BENEFIT-COST ANALYSIS (BCA)
OF
HAZARD MITIGATION PROJECTS

APPENDIX 1 to the

RIVERINE FLOOD - FULL DATA MODULE

USER'S GUIDE
FOR
SOFTWARE VERSION 5.2.3

FEDERAL EMERGENCY MANAGEMENT AGENCY

DISCLAIMERS

FEMA DISCLAIMER

The results produced by use of this Benefit-Cost Analysis Program are neither conclusive evidence that a proposed project is cost-effective, nor a guarantee that a project is eligible for any government grant for whatever purpose.

SOFTWARE DISCLAIMER

The software program accompanying this manual was developed under contract from the Federal Emergency Management Agency (FEMA).

FEMA and the software developers have checked this version carefully and have verified the results by comparison to earlier versions to ensure that the program is fully operable. However, users of this manual or the accompanying software assume responsibility for the results of calculations.

Please document and report any problems discovered with this version of the Benefit-Cost User's manual or software to the local Regional Office of the Federal Emergency Management Agency listed on the following page.

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TABLE OF CONTENTS

Overview

TABLE OF CONTENTS

CHAPTER 3: PROGRAM BASICS (continued)

CHAPTER 4: TUTORIAL (continued)

CHAPTER 4: TUTORIAL (continued)

CHAPTER 4: TUTORIAL (continued)

CHAPTER 6: BENEFIT-COST PROGRAM: LEVEL ONE ANALYSIS (continued)

CHAPTER 6: BENEFIT-COST PROGRAM: LEVEL ONE ANALYSIS (continued)

CHAPTER 6: BENEFIT-COST PROGRAM: LEVEL ONE ANALYSIS (continued)

CHAPTER 7: BENEFIT-COST PROGRAM: FLOOD HAZARD ANALYSIS (continued)

CHAPTER 8: BENEFIT-COST PROGRAM: LEVEL TWO ANALYSIS (continued)

CHAPTER 9: BENEFIT-COST PROGRAM: RESULTS (continued)

C H A P T E R 1

THE ROLE OF BENEFIT–COST ANALYSIS (BCA) IN HAZARD MITIGATION PROJECTS

Introduction

Acknowledgements

This manual and accompanying software were prepared by URS Group, Inc. (URS) for use by the Federal Emergency Management Agency (FEMA) in conducting Benefit-Cost Analyses (BCAs) of hazard mitigation projects. This module is applicable to **Riverine Flood** hazard mitigation projects; other modules are applicable to Coastal A-Zone Flood, Coastal V-Zone Flood, Hurricane Wind, and Seismic hazard mitigation projects.

Hazard Mitigation Projects

Hazard mitigation projects are specifically aimed at reducing or eliminating **future** damages. Although hazard mitigation projects may sometimes be implemented in conjunction with the repair of damages from a declared disaster, the focus of hazard mitigation projects is on strengthening, elevating, relocating or otherwise improving buildings, infrastructure or other facilities to enhance their ability to withstand the damaging impacts of **future** disasters. In some cases, hazard mitigation projects may also include training or public-education programs **if** such programs can be demonstrated to reduce **future** expected damages.

The Benefit-Cost (BC) Program

A BCA provides an estimate of the "benefits" and "costs" of a proposed flood hazard mitigation project. The **benefits** considered are **avoided** future damages and losses which are expected to accrue as a result of the mitigation project. In other words, benefits are the reduction in expected future damages and losses (i.e., the difference in expected future damages before and after the mitigation project). The **costs** considered are those necessary to implement the specific mitigation project under evaluation.

Costs are generally well determined for specific projects for which engineering design studies have been completed. Benefits, however, must be estimated probabilistically because they depend on the improved performance of the building or facility in future floods, the timing and severity of which must be estimated probabilistically.

The benefits considered in the **Benefit-Cost (BC) Program** include: avoided damages to the building and contents, avoided displacement costs, avoided rental and business income losses, and avoided loss of public/nonprofit services.

> **HELPFUL HINT**
>
> All discussions on the **BC Program** in this manual refer to the **Riverine BC Program.**

The "benefits" calculated by the program are expected future benefits which are estimated over the useful lifetime of the mitigation project. To account for the time value of money, a net present value calculation must be performed. This calculation is done automatically in the program, using the discount rate and project useful lifetime entered by the analyst. Results of BCA are presented two ways: first, the benefit-cost ratio (BCR) which are benefits divided by costs and second, the present value criterion (benefits minus costs).

Level One vs. Level Two BCAs

The **BC Program** is designed to facilitate two different levels of analysis. A **Level One (Minimum Data)** analysis relies heavily on default values built into the model and requires the minimum data input from users. A **Level Two (Detailed)** analysis allows the analyst to override default values with user-entered, building-specific estimates.

The validity of a BCA and the robustness of conclusions drawn therefrom depend entirely on the validity of the data used in the calculations. Calculations based on detailed, building-specific engineering analysis will be much more accurate (and correspondingly more useful) than calculations based largely on typical or default values of input parameters.

What Data are Needed for BCAs?

For any BCA of a hazard mitigation project, basic information about the building/facility under evaluation is required, including: building type, size, replacement value, contents value, and various economic data about the use and function of the building. Estimates of the vulnerability of the building and contents to flood damage both before and after mitigation are particularly important.

In most cases, few of the data inputs will be exact numbers. Rather, approximate data or informed, reasonable estimates will be used. See **Chapter 5, BC Program: Guidance** for helpful hints regarding exact data vs. reasonable estimates.

In addition to data about the building under evaluation, BCAs of flood hazard mitigation projects require a quantitative assessment of the degree

of flood risk at the site. This assessment is performed automatically by the **BC Program** using flood data input from a Flood Insurance Study (FIS) and a Flood Insurance Rate Map (FIRM), along with data on the **First Floor Elevation (FFE)** of the building. The degree of flood risk at a given site profoundly affects BCRs.

Myths and Misconceptions About BCAs

The benefits of hazard mitigation projects are avoided **future** damages. Benefits are **not** the damages experienced in the declared event, even if such damages would be 100% avoided by the mitigation project. Rather, benefits are the present value of the sum of expected avoided future damages for all levels of intensity of future disasters (e.g., floods).

To estimate future damages (and the benefits of avoiding them), the probabilities of future events **must** be considered. The probabilities of future events profoundly affect whether or not a proposed hazard mitigation project is cost effective. The benefits of avoiding flood damage for a building in the 10-year flood plain will be enormously greater than the benefits for an identical building situated at the 1,000-year flood elevation.

Mitigation **may not** be cost-effective even though a particular facility experienced great damage in the declared event, if the event were a low probability (i.e., a 500- or 1,000-year) event. Conversely, mitigation **may** be cost effective even though the particular facility experienced little or no damage in the declared event, **if** the probability of future damage is high.

The benefits of hazard mitigation projects for critical facilities such as hospitals, emergency operations centers, and fire stations, and for high occupancy facilities such as schools tend to be higher than the benefits of projects for non-critical or low-occupancy facilities. The higher benefits arise because future damages and losses may be high if the hazards are not mitigated. However, just because a proposed hazard mitigation project is for a critical facility does **not** guarantee that the project is cost-effective. On the contrary, **even for critical facilities,** hazard mitigation projects may **not** be cost-effective if the project is too expensive or the risk of future damage is not high enough.

Each proposed hazard mitigation project **must** be evaluated on its own merits to compare the benefits and costs of a specific project. There are no "rules of thumb" which determine eligible and ineligible projects because the costs and benefits of each project are different. The benefits of a particular project may vary markedly depending on the vulnerability of the existing facility to damages and losses, the probabilities of future damages, and the effectiveness of the mitigation measure in avoiding future damages.

Overview of User's Manual

The User's Manual provides a comprehensive guide to conducting BCAs of Riverine Flood Hazard Mitigation Projects.

Chapter 2, Getting Started, provides elementary guidance for novice users about loading and starting the BC Program.

Chapter 3, Program Basics, provides basic information about navigating within the program, making data entries, etc.

Chapter 4, Tutorial, provides an example problem which illustrates the process of entering data and obtaining a BCR.

Chapter 5, BC Program: Guidance, provides helpful hints for conducting BCAs, including data requirements, **Level One** and **Level Two** analyses, and expediting BCAs.

Chapter 6, BC Program: Level One Analysis, provides a detailed discussion of all the data inputs necessary for a **Level One (Minimum Data)** BCA.

Chapter 7, BC Program: Flood Hazard Risk, provides detailed information about modeling flood hazards and determining expected annual numbers of floods.

Chapter 8, BC Program: Level Two Analysis, provides a detailed discussion of the data inputs necessary for a **Level Two (Detailed)** BCA, including guidance on overriding default values with user-entered, building-specific data.

Chapter 9, BC Program: Results, provides a detailed discussion of the results of a BCA, including guidance on interpretation of results.

Chapter 10, BC Program: Print-Out, is a full print-out of a sample BCA, including all of the data entry screens, results screens, and the graphical presentation of data and results.

Chapter 11, Glossary, defines technical terms used in the program and in the user's manual.

Appendix 1, Equations, summarizes all of the underlying equations in the BC Program and defines all technical terms used in the equations.

CHAPTER 2
GETTING STARTED

Introduction

This chapter describes the computer hardware and software required to run the **Benefit-Cost (BC) Flood Program** and how to install it on a computer. **Chapter 3, Program Basics**, describes the basics of Microsoft Excel 5.0, how to get around in the **BC Program**, and how to enter the data requested. **Chapter 4, Tutorial**, provides a sample **Benefit-Cost Analysis (BCA)** with guidance for the novice user.

Excel works very much like other spreadsheet programs so that experience with any of them is nearly transferable to Excel. However, even if you have little or no experience with spreadsheet programs, the **BC Program** is self-contained and easy to use.

Hardware and Software Required

Computer Hardware

This **BC Program** requires an IBM-compatible computer (PC). The central processing unit (CPU) must be a 386 or higher; the program will run faster with a 486 or Pentium CPU. In addition, the computer **MUST** have:

1. At least 4 megabytes (MB), more is better, of memory (RAM),
2. A hard drive with at least 15 MB (more is better) of free disk space, and
3. A high density (HD) 3.5" floppy disk drive.

The **BC Program** files require a large amount of disk space, about 3 MB per file saved (i.e., for each BCA model run for a mitigation project). Therefore, it is desirable to have a large hard disk if you anticipate saving a substantial number of files. Alternatively, files can be saved on high density (HD) floppy disks. However, because of the file size (HD floppy disks hold only about 1.4 MB), the files **MUST** be compressed using utility programs (such as PKZIP). When compressed, each file is less than 1 mb. Files can also be saved on tape or Zip Drive back-up systems.

Computer Software

This **BC Program** is a **Windows based** program; therefore, your computer must have **Windows** (Version 3.1 or higher) installed before you load or run the **BC Program**.

All **Windows** programs require the use of a mouse (or trackball or touch pad); thus the computer system must have a mouse properly installed and operational.

Excel 5.0

The **BC Program** runs in **Microsoft Excel 5.0**. You must have **Excel 5.0** installed on your computer before loading or running the **BC Program**. Although the BC Program will run in later versions of Excel, it was written to run in Excel 5.0.

Installing the BC Program

Network Systems

Computer networks may be set up and managed in many different ways. Therefore, this manual cannot give detailed instructions for installing the **BC Program** on a specific network system. To install the program on a computer that is connected to a network system, give the program disk and the User's Manual to your computer system operator or network administrator. After installation is completed, go to the **Start Excel** section on page 9 of this manual.

There are three versions of the **Riverine BC Program**:

- RIVFD521.xls - Full Data version 5.2.1
- RIVLD52.xls - Limited Date version 5.2
- RVVLD523.xls - Very Limited Data version 5.2.3

Note: Although all three versions of the BC Program can used to evaluate cost-effectiveness of flood mitigation projects, this manual primarily discusses the **Full Data** version which involves the largest amount of input data. The **Limited Data** and **Very Limited Data** versions of the model require less input data and their results contain less detail than the **Full Data** version.

Stand-Alone Computers

1. Turn on the computer.
2. Create a new directory, called "**BC_FLOOD**" on the main drive (usually the C: Drive) of your computer.
3. Copy the three Riverine BC Programs (RIVFD521.xls, RIVLD52.xls, and RVVLD523.xls) into the **BC_FLOOD** directory.
4. You are now ready to prepare BCA evaluations using Excel 5.0.

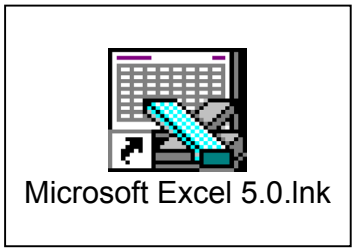
Reminder: The most detailed module of the three programs is the Full Data Version (RIVFD521.xls).

CHAPTER 3
PROGRAM BASICS

Starting Excel 5.0

Start Windows

Excel 5.0 is a **Windows** based program; therefore you must first start **Windows** before starting Excel.



HELPFUL HINT

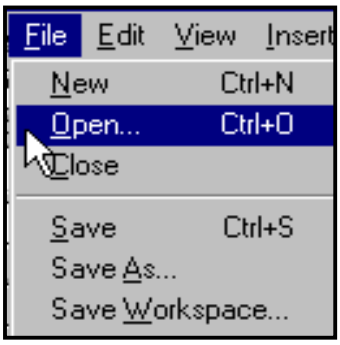
In this manual, when you read "click on", it is a short way to say "click on the right mouse button. Unless specifically cited as "left," all references to "clicking on the mouse" will refer to the right mouse button.

Excel works very much like any other Windows spreadsheet programs (e.g., Lotus 1-2-3)). Excel commands are initiated by clicking on pull-down menus at the top of the screen or by clicking on the speed buttons below the menu lines.

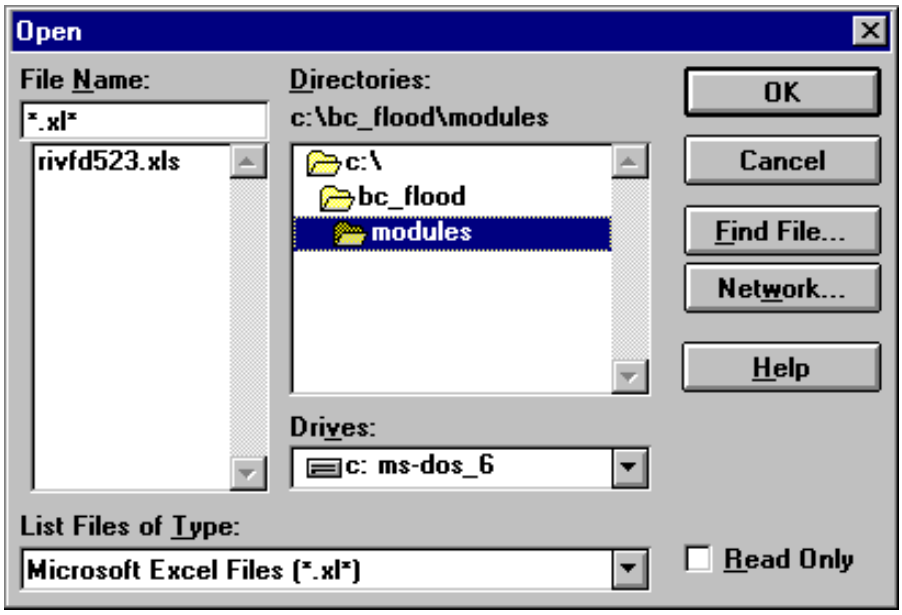
To use the Benefit-Cost (BC) Program, you need to know some basic information about Excel. Once the BC Program is loaded, the data entry, calculations, and printing of results can be accomplished entirely within the program, with minimal use of Excel commands.

Opening Files

The menu bar along the upper edge of the Excel window will display a **File** command at the left side. Click on the **File** command. When the menu opens, click on the **Open** command.



The screen will display the **Open** window that contains among others, two boxes, side by side: **File Name** and **Directories.**



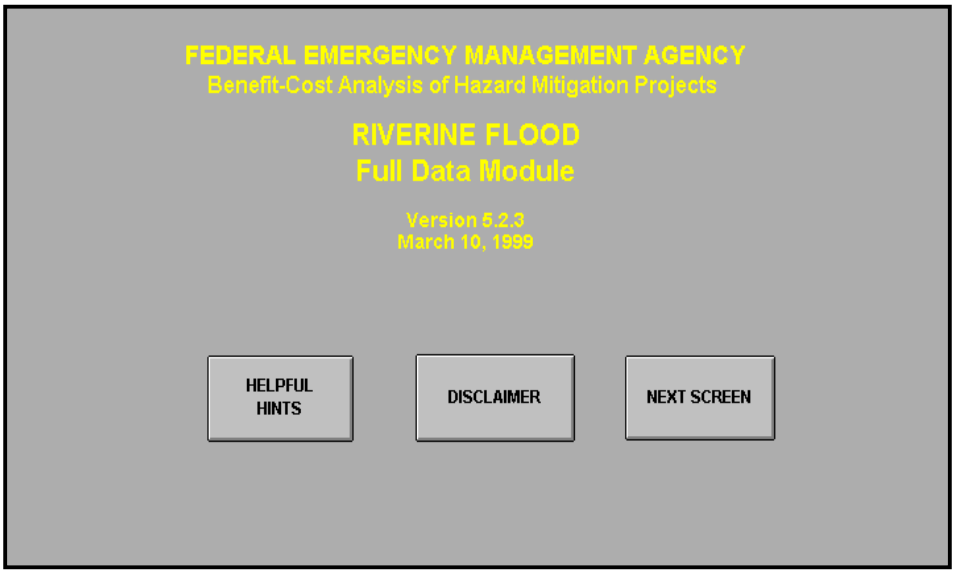
If the **C:** drive is not listed at the top of the **Directories** list, double click on **C:** in the **Drives** box on the bottom center of the screen. Use the mouse to move the cursor to the **BC_ FLOOD** directory where the BC Programs are located, and double click. All of the files ending in .xls will be listed in the **File Name** box at the left.

Use the mouse to highlight and double click on the **RIVFD523.xls** line to open the BC Program. Clicking once on the file name and then on OK may also open files.

The computer will load the **BC Program**. Loading may take from a few seconds up to several minutes, depending on the speed of the computer. The bottom right corner of the screen will display a status line, which expands from left to right, until the program is loaded.

Start Screen Display

When the BC Program is loaded, the first screen visible is the **BC Program Start Screen**.



Zoom Menu

If the words extend past the right side of the computer screen or if the image is too small, open the **Zoom** portion of the menu and click on 100%.

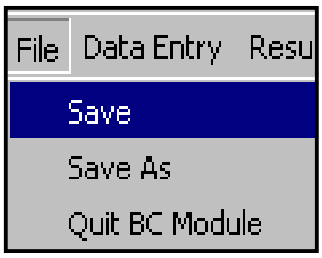
First time users should click once on the Helpful Hints and Disclaimer buttons to read the contents.

Basic Commands and Procedures

Naming and Saving Files

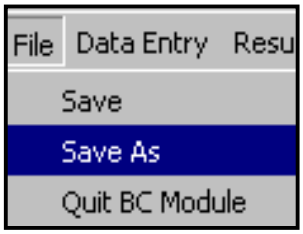
Each BC Program run you wish to save **MUST have a unique name** to avoid writing over the original file. If you choose (i.e., click on) the **Save** command, under the File menu, any data input or results will automatically be saved under the filename of **RVFD521.xls** (i.e. the original filename).

Save



Save As

If you choose **Save As**, a unique name can be entered as a file is saved. Click on **File** (in the menu on the top line of the screen), then click on **Save As**. This saves revisions and new data inputs under a new file name.



The Save As window will open on the screen with an assumed new filename of "new_name.xls" appearing in the file title box of the window. The assumed filename will be highlighted. Using the keyboard, type a new filename over the assumed filename. Filenames may have up to eight characters or numbers and must have a file extension of .xls. After typing the new file name, click on **OK** to save the file.

HELPFUL HINT

Prior to entering data, the analyst is strongly encouraged to save the BC Program under a new filename to avoid overwriting the source file for the BC Program.

HELPFUL HINT

All files must have the file extension of ".xls" for use within Excel.
For example: if you want to save a file as Run17, save the file as Run17.xls. Then, when you use the File and Open commands, Excel automatically lists all files in which the file extension (the three letters after the period) begins with .xls and thus, your program files will be easy to find.

OOPS!

If you accidentally overwrite one of the original BC Program files by saving a file with user-entered data without changing the name, the original program file will be lost (i.e. overwritten by the new file). To recreate the original program file, recopy the RIVFD523.xls file into the BC_FLOOD directory as described on page 7 of Chapter 2.

Start a New Benefit-Cost Analysis (BCA)

If you want to prepare another BCA (i.e., run the BC Program again, with different inputs):

1. Save the existing open file with a new name (see **Naming and Saving Files**, page 11).
2. Click on **File** (in the menu at the top of the screen), select Quit Riverine Module. This will close the existing file while prompting the analyst to save any data entered or revised while the file was open. The screen will then return to a blank Excel 5.0 screen. If data has either been entered or revised and the analyst has chosen not to save the changes, the BC Program will prompt the analyst twice to verify that the changes should be discarded before closing the file.

3. Click on **File**, then click on **Open** to start a new analysis (see Opening Files, page 10).

Exit From the BC Program

1. Save the work with a new name, by using the **File** and **Save As** commands described above.
2. Click on **File**, then click on **Quit Riverine Module** to leave the BC Program.

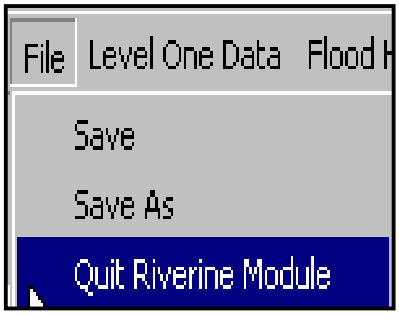
Run a Different BC Program

If you want to run a different BC Program (e.g., the **Coastal A-Zone Program** instead of the **Riverine Program**):

1. See **Opening Files** on page 10.
2. Select the appropriate directory (e.g., **BC_FLOOD** or **BC_CST_A**) for the desired Program.
3. Open **RIVFD523.xls** or another previously named file.

Exit from Excel

To exit from Excel, you must first exit from the **BC Program**. With the mouse, highlight **File** and **Quit Riverine Module**. This will close the program after first prompting the analysts twice to save the new or revised data entries. This step will close the BC Program and return the analyst to a blank Excel screen.



Next, with the mouse, highlight the **File** menu within Excel and then click on **Exit** to close Excel.

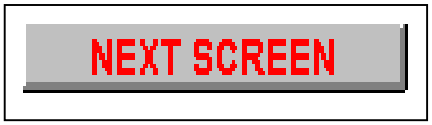
Moving Around in the Program

Navigation in the BC Program

There are several easy ways to move around in the BC Program:

1. Use the mouse to place the cursor wherever you want to be on a page and click on that location to enter or edit data.
2. Editing previously entered data should be done within the edit line at the top of the screen, just below the Benefit-Cost (BC) Program menu.

3. To move **left-right** on a page, use the cursor arrows on the keyboard, or the horizontal scroll bar at the bottom right of the screen.
4. To move **up-down** on a page, use the cursor arrows on the keyboard, or the vertical scroll bar at the right hand edge of the screen.
5. To move to the **left edge of any page** in the program, press the **Home** button on the keyboard.
6. To proceed sequentially through the BC Program, click on the **Next Screen Button**, at the bottom right of each page.



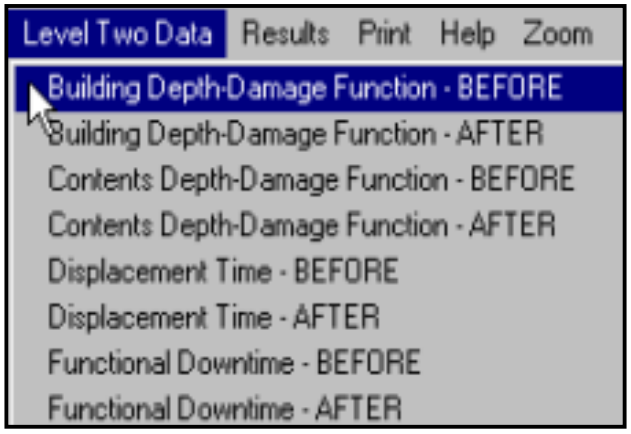
7. To move to a specific location within the program, use the custom **Menu** (described next) which appears at the top of the screen. Click on the desired menu item and a submenu (a list of available choices) appears. Click on the desired submenu item.

BC Menu

The BC Program is driven from a customized menu. Menu items can be accessed by clicking on the desired menu label. The menu appears at the top of the display screen (after the program is opened):

In addition to the main menu, there are submenus that appear when a main menu heading is opened. Submenus are accessed in the same manner as the main menu headings

For example, to move to the **Building Depth-Damage Function - BEFORE** screen, click on **Level Two Data,** then click on **Building Depth-Damage Function – BEFORE** line.



The complete BCA Menus are given below:

Customized BC Program Menus

- **File**
- **Save**
- **Save As**
- **Quit Riverine Module**

Level One Data

- **Project Information**
- **Building Data**
- **Building Contents**
- **Displacement Costs**
- **Value of Public/Nonprofit Services**
- **Rent & Business Income**
- **Mitigation Project Data**

Flood Hazard

Level Two Data

- **Building Depth-Damage Function - BEFORE**
- **Building Depth-Damage Function - AFTER**
- **Contents Depth-Damage Function - BEFORE**
- **Contents Depth-Damage Function - AFTER**
- **Displacement Time – BEFORE**
- **Displacement Time – AFTER**
- **Functional Downtime – BEFORE**
- **Functional Downtime – AFTER**

Results

- **Damages Before Mitigation**
- **Damages After Mitigation**
- **Benefits**
- **Benefit Cost Results**
- **Summary**

Print

- **Summary**
- **Report**
- **Graph Hazard Data**
- **Graph Damages Before Mitigation**
- **Graph Damages After Mitigation**
- **Graph Benefits**
- **Graph BC Results**
- **All Graphs**

Help

- **Color Codes**
- **Version**

Zoom

- **25%**
- **50%**
- **75%**
- **80%**
- **90%**
- **100%**
- **125%**
- **150%**
- **Custom**

Cell Colors

Before beginning the data entry process, note that all areas (blocks or cells) of the program screens are color coded to remind the user what type of information each cell contains.

In the BC Program, background space is white and identifying labels, such as "Building Name," have black text on white backgrounds. These labels are fixed and can not be changed. There are **seven** colors which indicate different types of data entries or calculated results:

BROWN Blocks (Default) contain default data which vary depending on the building type selected and other user-determined inputs.

DARK BLUE Block (OMB Policy) contains the discount rate entry that is defined by OMB or FEMA policy and thus is not a user-defined entry.

GREEN Blocks (Data Input) require the analyst to enter data concerning the building or project and directly affect the calculated results.

LIGHT BLUE Blocks (Override Default) can be used to override default data with project-specific data.

PINK Blocks (Information Only) contain information about the building or project and do not affect the calculated results.

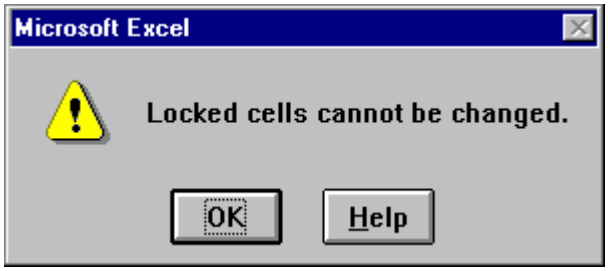
PURPLE Blocks (Carry Over) contain information that was entered by the user in other screens.

YELLOW Blocks (Results) contain calculated results from the program.

Unprotected Blocks

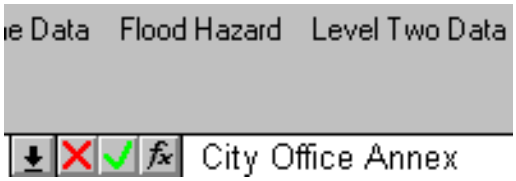
User data entries can be made **ONLY** in **GREEN, PINK, LIGHT BLUE, or DARK BLUE** blocks. "Unprotected" means that data entries **CAN** be made within these blocks.

Protected Blocks



Blocks colored **BROWN, YELLOW**, and **PURPLE** are protected. The background, or normal blocks, which appear **WHITE** are also protected. User entries **CANNOT** be made in these blocks. To change information in **PURPLE blocks (Carry Over)** the original data entries in the **PINK** or **GREEN** blocks must be changed. To change entries in the **BROWN** or **YELLOW** blocks**,** the underlying selections or data entries which affect these blocks must be changed.

Data Entry



To enter data into a block (or cell) in the program, first move the cursor to the block where you want to enter the data. Then, type the desired information. As you type, the characters appear in the **Input Line** just below the menu.

After entering the data, press **Enter,** an arrow key or use the mouse to move to another data input area.

HELPFUL HINT

User data entries can be made only in the GREEN, PINK, LIGHT BLUE or DARK BLUE data entry blocks.

If you attempt to enter data in cells which are not **GREEN, PINK, LIGHT BLUE,** or **DARK BLUE** you will see an error message that informs the analyst that "Locked cells cannot be changed". Other cells are **"locked"** to prevent inadvertent changes to the program. As with other error messages, click on **OK** or press the **Esc** key to return to data entry.

Correcting Errors

If you make a mistake while typing, press the **Backspace** key on the keyboard to erase. To clear the entire entry, press the **Delete** button on the keyboard.

After pressing **Enter**, if you find you made a typing mistake or want to change an entry, first select the cell which you wish to change by clicking on the cell. Then, type the entry over again or click inside the text on the **Input Line** (see **Data Entry** above) and edit it there. To delete an entry without replacing it, just select the cell (by clicking on the mouse in the desired cell) and press the **Del** button on the keyboard.

Entering Commas and Dollars

Excel will accept entries that include either a dollar sign or commas. Thus, twenty thousand square feet can be entered as either 20000 or 20,000. A cost of $10,000 can be entered as 10000, $10000, or $10,000. The "$" and "," are inserted automatically.

CHAPTER 4
TUTORIAL

This chapter works through a sample **Level One** (see definition below) data entry exercise and Benefit-Cost Analysis (BCA). This tutorial is provided primarily for the less experienced computer user. To use the tutorial to enter data in a blank Benefit-Cost (BC) Program, follow the instructions which start on page 22.

Level One and Level Two BCAs

A **Level One (Minimum Data) BCA** relies heavily on default values and requires a minimum of user-specified data entries. A **Level Two (Detailed) BCA** relies less on default values and incorporates additional building-specific data.

Level One (Minimum Data) BCA

By entering the information on the **Level One Data** pages and the **Flood Hazard Data**, the program will perform a BCA for the proposed mitigation project. Additional data, which the model requires for calculations, are included in the program as "default values."

For general guidance on how to perform a BCA, see **Chapter 5, Benefit-Cost (BC) BC Program: Guidance**.

For a detailed explanation of the data entries for a **Level One** analysis, see **Chapter 6, BC Program: Level One Analysis**.

For a detailed explanation of flood data entries, see **Chapter 7, BC Program: Flood Hazard Risk**.

HELPFUL HINTS:

This tutorial is for a Level One (Minimum Data) analysis which relies heavily on default values built into the program.

A Level One (Minimum Data) analysis may be appropriate for small, low-cost projects, or as an initial screening of larger projects to assess whether more detailed analysis is warranted.

A Level One analysis is appropriate only if flood damages are due predominantly to water depth and not to high velocity flow, debris impacts, erosion, or soil failure.

Level Two (Detailed) BCA

Analysts are encouraged to perform a **Level Two (Detailed)** BCA whenever possible. A **Level Two** analysis will provide the most accurate results by incorporating much more building-specific data and judgments than a **Level One** analysis. See **Chapter 8, BC Program: Level Two Analysis** for a detailed discussion of **Level Two** data entry.

HELPFUL HINTS:

A Level Two (Detailed) analysis is appropriate for large, high-cost projects, projects which are politically sensitive, or projects where initial screening indicates that benefit-cost ratios (BCRs) are close to one.

A Level Two analysis MUST be conducted whenever flood damages are significantly affected by high velocity flows, debris impacts, erosion or soil failures.

The following tutorial is for the **Level One (Minimum Data)** BCA.

Starting the Tutorial

Step One Start Excel 5.0. (Refer to page 9.)

Step Two Open the desired **BC Program** file. See instructions (**Opening Files**) on page 10. For the tutorial, open the RIVFD523.xls and save the file under the filename: "Demo1.xls." Continue the tutorial by entering the data discussed below into Demo1.xls.

Step Three The **Sign-On** screen appears after the **BC Program** is opened. Adjust the **Zoom** factor which controls the size of the screen display, if necessary. The default value for the Zoom setting is 80%. (See **Opening Files** and **Basic Commands and Procedures** in Chapter 3.)

Step Four Proceed through the Data Input process, as outlined below in the tutorial example. This example leads an analyst through the **Level One (Minimum Data)** BCA data input process. Click on the **NEXT SCREEN** button to the right of center on the **Sign-On** Screen to begin the data entry process.

Clicking this button on the **Sign-On** screen moves you to the **Level One DATA** screen, where the data entry process begins.

HELPFUL HINT:

For definitions and detailed explanations of the data entries, see Chapter 6, BC Program: Level One Analysis and Chapter 7, BC Program: Flood Hazard Risk.

HELP Buttons HELP Buttons are located throughout the BC Program and provide guidance or assistance to the analyst through definitions or explanations about data requested for the adjacent data entry blocks.

LEVEL ONE DATA

Project Information

Building Name	City Office Annex
Address	55 A Street
City, State, Zip	Alworth, VA 22222
Owner	City of Alworth
Contact Person	Sam Smith, City Manager
Disaster Number	FEMA-XXXX-VA
Project Number	1234
Application Date	March 6, 1999
Discount Rate (%)	7.00 %
Scenario Run ID	2
Analyst	R. Johnson

Building Name

PINK Blocks (Information Only). Using the mouse, move the cursor to the first pink-colored block, **Building Name**, and click on the block.

IMPORTANT: The cursor must be in the first space inside the pink block.

Type the name of the building, i.e., **City Office Annex**. Press the **Enter** key. As you make data entries, remember that **PINK** blocks are for information only; they serve to identify the project under evaluation, but do not affect the BC results. Entries in the **DARK BLUE** block and the **GREEN** blocks do affect numerical results.

Address

Then, with the mouse or the arrow keys, move the cursor to the street **Address** and enter the following data: **55 A Street**. Move to the next entry.

City, State, Zip Code

PINK Block (Information Only). Enter the city, state, and zip code for the building: **Alworth, VA 22222**. Move to the next entry.

Owner

PINK Block (Information Only). Enter the name of the building owner. This may be an agency, a private party, etc. Enter: **City of Alworth**. Move to the next entry.

Contact Person

PINK Block (Information Only). Enter **Sam Smith, City Manager**, for the building manager, or other contact person who could provide information about the building to the analyst. Move to the next entry.

Disaster Number

PINK Block (Information Only). Enter disaster number (assigned by FEMA), as **FEMA-XXXX-DR-VA**. Move to the next entry.

Project Number

PINK Block (Information Only). Enter project number **1234**. Move to the next entry.

Application Date — **PINK Block (Information Only).** Enter **March 6, 1999**. Move to the next entry.

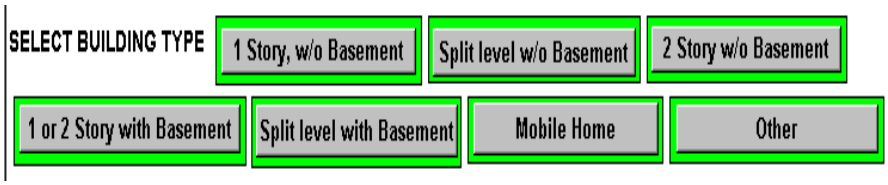
Discount Rate (%) — **DARK BLUE Block (OMB Policy).** The discount rate of 7% is already entered. See page 48 for a discussion of the discount rate. Move to the next entry.

Scenario Run ID — **PINK Block (Information Only).** Enter the scenario run number **2**. Move to the next entry.

Analyst — **PINK Block (Information Only).** Enter your last name. Move to the next entry.

Building Data

SELECT BUILDING TYPE



There are six choices for building type within the BC Program:

1. 1 Story w/o Basement
2. Split level w/o Basement
3. 2 Story w/o Basement
4. 1 or 2 Story with Basement
5. Split level with Basement
6. Mobile Home
7. Other

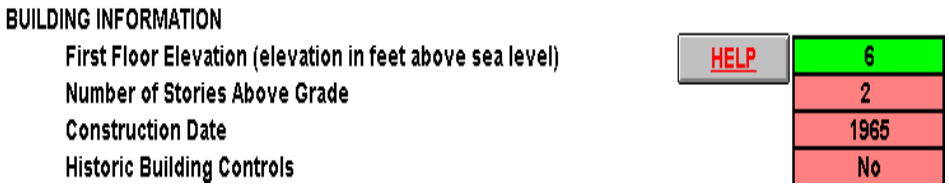
The mouse must be used to click on the appropriate **GRAY Button** with the green background; the arrow keys will not operate these buttons. For this example, click on the button labeled: **2 story w/o basement**. This choice will automatically appear in the **PURPLE Block** labeled "Building Type Selected."

HELPFUL HINT:

If you are unable to click on a button, press "Enter" to ensure that the data entry has been completed for the last data block.

Use the scroll bar along the right edge of the screen to move downward (or upward) on the screen.

BUILDING INFORMATION



First Floor Elevation (FFE)

GREEN Block (Data Input). Enter **6** as the **First Floor Elevation, or FFE** (the top of the lowest finished floor) for this building. An explanation of **FFE** can be viewed through the adjacent **Help** button on the screen. Move to the next entry.

Number of Stories Above Grade

PINK Block (Information Only). Enter **2** as the **Number of Stories Above Grade**. Move to the next entry.

Construction Date

PINK Block (Information Only). Enter **1965** as the **Construction Date**. Move to the next entry.

Historic Building Controls

PINK Block (Information Only). Enter **No** in the **Historic Building Controls** box. Move to the next entry.

BUILDING SIZE AND USE

Total Floor Area (sf)

GREEN Block (Data Input). Enter **2000** and the screen will display this as **2,000** when you confirm the entry by pressing **Enter** or move to the next data entry block.

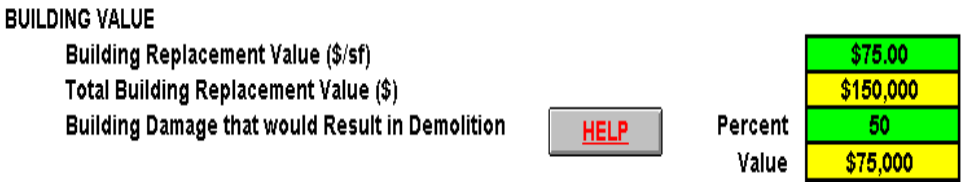
Note: This refers to the <u>Total</u> Floor Area which is the product of the building footprint (in square feet) and the number of stories above ground. The total floor area does not include basement or crawl space areas.

If you make a mistake, use the backspace key to erase, then enter the information correctly.

Area Occupied by Owner or Public/Nonprofit Agencies (sf)

GREEN Block (Data Input). Enter **1500** for the total amount of space (in square feet) occupied by the owner or public/nonprofit agencies. Move to the next entry.

BUILDING VALUE



Building Replacement Value ($/sf)

GREEN Block (Data Input). Enter **75** as the building's value per square foot. Move to the next entry.

Total Building Replacement Value ($)

YELLOW Block (Result). The program automatically calculates **$150,000** ($75/sq. ft. x 2,000 sq. ft.) as the building's total replacement value and displays it in the **yellow block**. Move to the next entry.

Building Damage that would Result in Demolition

GREEN Block (Data Input). This represents the percent of building damage at which demolition and replacement (rather than repair) are expected to occur. This is also known as the "demolition threshold." This block contains a default value of 50 (for 50%). This can be overwritten by another amount if building-specific information is available.

For the tutorial, leave the default value at **50**. Move to the next entry.

YELLOW Block (Result). The program displays **$75,000** (50% of $150,000) for the dollars of building damage at which demolition and replacement (rather than repair) would be expected to occur. An explanation of the Demolition Damage Threshold can be viewed through the adjacent Help button on the screen. Move to the next entry.

Building Contents

Contents Description

PINK Block (Information Only). Enter **Office furniture, computers, & files** as the description of the building's contents. Move to the next entry.

Total Value of Contents

GREEN Block (Data Input). Enter **50000** as the total contents value. The "**$**" sign and the comma are entered automatically. Move to the next entry.

Value of Contents ($/sf)

YELLOW Block (Result). The program displays **$25.00** as the value of contents in dollars per square foot of building space. Move to the next entry.

Displacement Costs Due To Flood Damage

DISPLACEMENT COSTS DUE TO FLOOD DAMAGE	
Rental Cost of Temporary Building Space ($/sf/month)	$1.50
Rental Cost of Temporary Building Space ($/month)	$2,250
Other Costs of Displacement ($/month)	$500
Total Displacement Costs ($/month)	$2,750
One-Time Displacement Costs($)	$1,500

Rental Cost of Temporary Building Space ($/sf/month)

GREEN Blocks (Data Input). Enter **1.50** (for $1.50) as the rental cost of temporary building space in dollars per square foot per month.

For less than whole dollar amounts, the analyst must include a decimal point when entering data into the block. Without a decimal point, the BC Program will assume that a decimal point occurs to the right of the last digit entered.

Move to the next entry.

Rental Cost of Temporary Building Space ($/month)

YELLOW Block (Result). The program displays **$2,250** as the monthly rental cost of temporary building space. Move to the next entry.

Other Costs of Displacement ($/month)

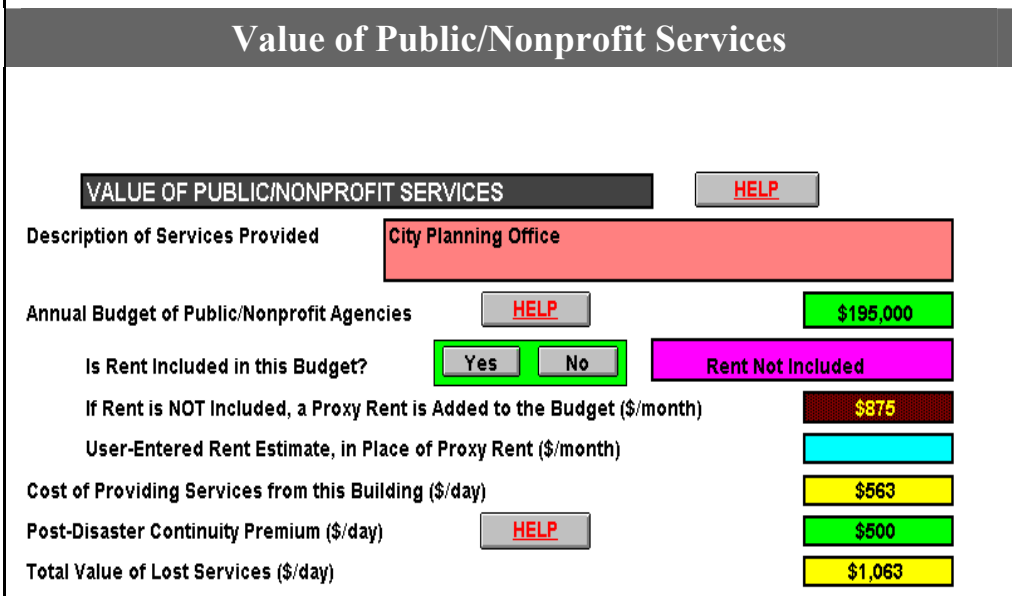
GREEN Block (Data Input). Enter **500** (for $500) as the estimated monthly cost of all other non-rent costs associated with displacement. Other costs include temporary equipment that is leased or rented, temporary furnishings that are leased or rented, etc. Move to the next entry.

Total Displacement Costs ($/month)

YELLOW Block (Result). The program will display **$2,750** as the calculated total displacement cost per month. Move to the next entry.

One-Time Displacement Costs ($)

GREEN Block (Data Input). Enter 1500 (for $1,500) as the estimated one-time cost for being displaced. This cost includes moving costs, replacement costs for clothing and personal items, costs for transferring utility services, etc. Move to the next entry.



Description of Services Provided

PINK Block (Information Only). Enter **City Planning Office**. An explanation of the Value of Public/Nonprofit Services can be viewed through the adjacent Help button. Move to the next entry.

Annual Budget of Public/Nonprofit Agencies

GREEN Block (Data Input). Enter **195000** (for $195,000) as the total annual budget for all the public/nonprofit agencies operating out of this building. The total budget should **exclude** pass-through amounts such as Social Security payments.

An explanation of the Annual Budget of Public/Nonprofit Agencies can be viewed through the adjacent Help button. Move to the next entry.

Is Rent Included in this Budget?

Click on the **NO** button to indicate that rent is not included. The program displays "**Rent Not Included**" under the **$195,000** annual budget block just above. When rent is not included in the annual budget, the program calculates a default or proxy rent based on the value of the building and displays it in the **BROWN Block (Result)** on the next line. Move to the next entry.

User-Entered Rent Estimate ($/month)

LIGHT BLUE Block (Override Default). The analyst can override the default value in the BROWN Block (for Proxy Rent) by entering another value here. However, for the purpose of the tutorial, leave this entry blank. Move to the next entry.

Cost of Providing

YELLOW Block (Result). The Benefit-Cost (BC) Program calculates

Services from this Building ($/day)

$563 as the estimated daily cost of providing services from this building. Move to the next entry.

Post-Disaster Continuity Premium ($/day)

GREEN Block (Data Input). Enter **500** (for $500) as a daily continuity premium. An explanation of the Post-Disaster Continuity Premium can be viewed through the adjacent Help button. Move to the next entry.

Rent & Business Income

Total Monthly Rent from All Tenants ($/month)

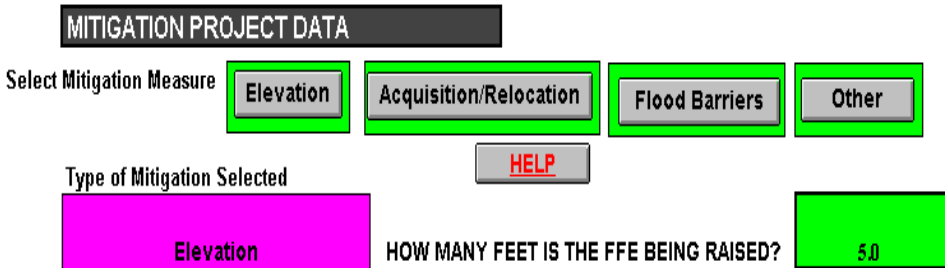
GREEN Block (Data Input). Enter **500** (for $500), as the total monthly rent received from all tenants in the building, excluding public/nonprofit agencies ($/month). Move to the next entry.

Estimated Net Income of Commercial Businesses ($/month)

GREEN Block (Data Input). Enter **1500** (for $1,500) as the estimated net income of commercial businesses in the building ($/month). Move to the next entry.

Mitigation Project Data

Select Mitigation Measure



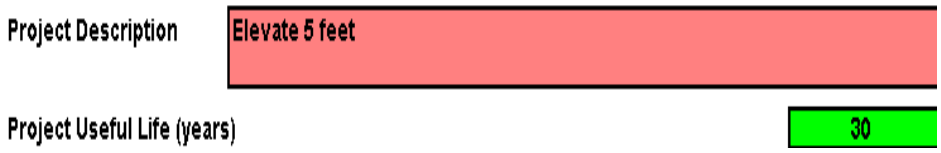
Select one of the four possible mitigation measures:

1. Elevation
2. Acquisition/Relocation
3. Flood Barriers
4. Other

An explanation of the data requirements or assumptions for the mitigation measures can be viewed through the adjacent Help button. With the mouse, select the **Elevation** button for this tutorial. The program will display this choice in the purple block.

If the Elevation button is selected, the analyst must enter the number of feet the building will be raised above the current FFE.

If the Flood Barrier (i.e., levee, floodwall, or dry floodproofing) is selected, the analyst must also enter the elevation of the Top of the barrier (in feet above sea level). Do not enter the height of the flood barrier. This data will be referenced to the flood hazard information to determine the effectiveness, or level of protection, of the mitigation project.



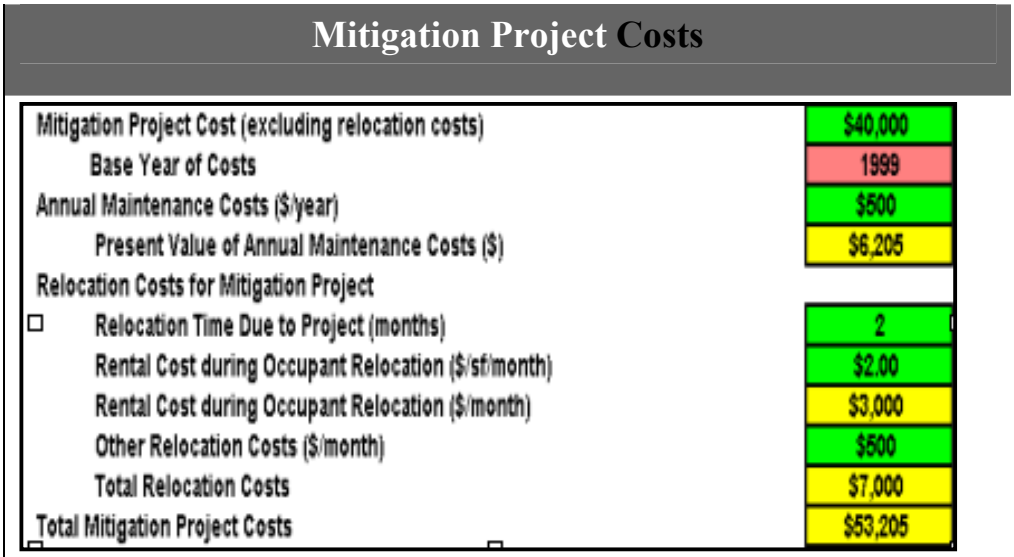
Project Description

PINK Block (Information Only). Enter **Elevate 5 feet**. Move to the next entry.

Project Useful Life (years)

GREEN Block (Data Input). Enter **30** as the number of years of useful life expected from this mitigation measure. Move to the next entry.

Mitigation Project Costs



GREEN Block (Data Input). Enter **40000** (for $40,000) as the mitigation project cost, excluding relocation costs. Move to the next entry.

Base Year of Costs

PINK BLOCK (Information Only). Enter **1999**. Move to the next entry.

Annual Maintenance Costs ($/year)

GREEN Block (Data Input). Enter **500** (for $500) as the annual maintenance costs. Move to the next entry.

Present Value of Annual Maintenance Costs ($)

YELLOW Block (Result). The BC Program calculates **$6,205** as the present value of annual maintenance costs. This calculation is based on the annual maintenance costs, the project useful lifetime, and the discount rate. Move to the next entry.

Relocation Costs For Mitigation Project

In this section, the time and costs associated with occupant relocation during the construction of the mitigation project are estimated.

Relocation Time Due to Project (months)

GREEN BLOCK (Data Input): Enter **2** (for 2 months) for the relocation time necessary during the construction or implementation of the mitigation project. ***Remember to include a decimal point to correctly define the unit cost.*** Move to the next entry.

Rental Cost During Occupant Relocation ($/sf/month)

GREEN Block (Data Input): Enter either **2** or **2.00** (for $2.00 per square foot per month) as the rental cost during occupant relocation for the mitigation project. Move to the next entry.

Rental Cost During Occupant Relocation ($/month)

YELLOW Block (Results): The program displays **$3,000**, as the monthly rental cost incurred during occupant relocation for the mitigation project. Move to the next entry.

Other Relocation Costs ($/month)

GREEN Block (Data Input). Enter **500** (for $500) for other relocation costs per month. Move to the next entry.

Total Relocation Costs

YELLOW Block (Result). The program displays **$7,000** as the total relocation costs for the mitigation project. Move to the next entry.

Total Mitigation Project Costs

YELLOW Block (Result): The program displays **$53,205** as the total mitigation project costs. This total includes the sum of the mitigation project cost, the present value of the annual maintenance cost, and the relocation cost for the project.

Next Screen

Click on either the **NEXT SCREEN** button or Hazard under the Flood Hazard Menu to continue data entry and proceed to the **FLOOD HAZARD** screen.

FLOOD HAZARD

Reference Information From Level One Data

PURPLE Block (Carryover): The program displays "6" (for 6 feet) which has been carried over from the **First Floor Elevation (FFE)** data entry under **BUILDING INFORMATION** on the Level One data entry screen.

Flood Hazard Data

FLOOD HAZARD DATA

Data from Flood Insurance Study (FIS)

Flood Frequency (years)	Discharge (cfs)	Elevation (ft)
10	279,000	5.3
50	361,000	7.4
100	377,000	8
500	444,000	9.5

GREEN Blocks (Data Input). Complete the **Flood Hazard Data** table with the information as shown above, for **Flood Frequency**, **Discharge,** and **Elevation**. These data, along with the **FFE** of the facility under evaluation determine the extent of flood risk at the site. For more information about how flood hazards are modeled in the program, see **Chapter 7, BC Program: Flood Hazard Risk**.

Expected Annual Number of Floods

The default estimates of the Expected Annual Number of Floods of each flood depth from -2 to +8 feet or greater are shown in the BROWN (Default) column. These estimates are calculated from the flood frequency, discharge and elevation data entered previously. "Expected annual number" of floods does not mean that this number of floods occurs every year, but rather "expected" indicates the long-term statistical average number of floods per year.

Except when annual probabilities approach one, the expected annual number of floods and the annual probability for each flood depth are virtually identical.

For a Level One analysis, these default estimates of the expected annual number of floods at the site under evaluation should be used.

Help Button

An explanation of the Expected Annual Number of Floods can be viewed through the adjacent Help button.

Data Sources and Documentation

PINK Block (Information Only). This comment box may be used to record specific information about the FEMA Flood Insurance Study (FIS). Enter "FEMA FIS data for Alworth, VA, dated September 8, 1979" to cite the source of the data used in this sample Benefit-Cost Analysis (BCA).

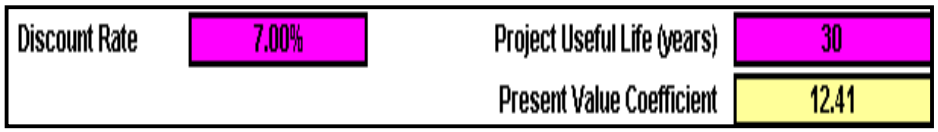
You have now completed the Level One (Minimum Data) BCA data entry process.

RESULTS

Benefit-Cost Results

Use the mouse to highlight the **Results** menu, and then click **Benefit-Cost Results**. The program will then move to the **Benefit-Cost Results** screen.

Present Value Coefficient



YELLOW Block (Result). The program displays **12.41** as the present value coefficient. The **Present Value Coefficient** is the present value of $1.00 per year in benefits received over the project useful lifetime. The **Present Value Coefficient** is calculated from the **Project Useful Life** and the **Discount Rate**, which are carried over, (i.e., the **PURPLE Blocks**), from the **Level One Data** entry page and displayed here for reference.

Summary of Expected Damages and Benefits

Expected Damages And Benefits Table

SUMMARY OF EXPECTED DAMAGES AND BENEFITS

	Expected Annual Damages Before Mitigation	Expected Annual Damages After Mitigation	Expected Annual Benefits	Present Value of Annual Benefits
Building Damages	$1,052	$9	$1,042	$12,936
Contents Damages	$526	$5	$521	$6,468
Displacement Costs	$142	$1	$140	$1,741
Business Income Lost	$35	$0	$35	$431
Rental Income Lost	$21	$0	$21	$256
Public Services Lost	$745	$7	$739	$9,166
Total Losses & Benefits	$2,521	$23	$2,498	$30,999

YELLOW Blocks (Results). For each category listed in the table above, the program displays the calculated results: **Expected Annual Damages Before and After Mitigation, Expected Annual Benefits,** and the **Present Value of the Annual Benefits**. See **Chapter 9, BC Program: Results**, for a detailed discussion of these results and how to interpret them.

Summary of Project Benefits and Costs

Benefits and Costs Table

SUMMARY OF PROJECT BENEFITS AND COSTS

PROJECT BENEFITS		$30,999
PROJECT COSTS	GRAPH	$53,205
BENEFITS MINUS COSTS		($22,205)
BENEFIT-COST RATIO		0.58

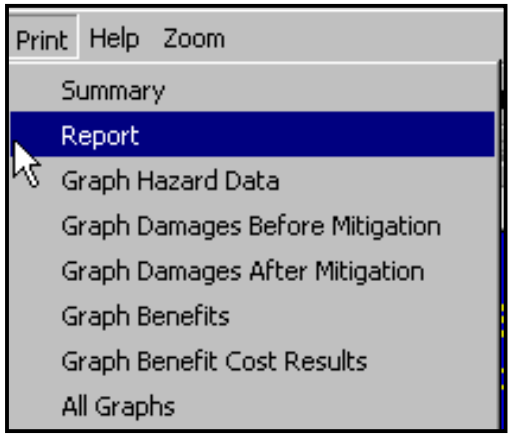
Project Benefits	**YELLOW Block (Result)**. The program displays **$30,999** as the present value of damages avoided, which are the calculated benefits for the mitigation project. This value is the "bottom line" or the calculated benefits of the project and is the result of all the data inputs previously made.
Project Costs	**YELLOW Block (Result)**. The program displays **$53,205** as the total costs of the proposed mitigation project.
Benefits Minus Costs	**YELLOW Block (Result)**. The program displays **($22,205)** as the difference between the **Project Benefits** (i.e., the present value of total damages and losses avoided) and the total **Project Costs** of the mitigation project. This result indicates that for the particular project evaluated the benefits are less than the costs by $22,205.
Benefit-Cost Ratio (BCR)	**YELLOW Block (Result)**. The program displays **0.58** as the ratio of benefits to costs for the proposed mitigation project. This means that each $0.58 in benefits from the project carries a cost of $1.00. Thus, project costs are greater than the benefits and the project, as currently defined, is <u>not</u> cost-effective.
Next Screen	Click on either the NEXT SCREEN button or Summary under the Results Menu to continue data entry and proceed to the SUMMARY screen.

Summary

The Summary contains a compilation of all the data inputs which affect the numerical values within the BC results. There is no user-entered data on the Summary page.

Print Menu

PRINT MENU



Click on the **Print** menu to display the available choices for printing. Click the mouse button on the appropriate item in the **Print** menu to print any desired item.

The **Print** menu controls printing of the Summary page, the multi-page Report, and any or all of the graphs included in the Benefit-Cost (BC) Program. The **Summary** page contains a one-page compilation of all of the data inputs that affect the BC Results. The **Report** is a 12-page print-out of the full Data and Results screens from the BC Program, including the BC Results Summary page, but without the Help buttons or the color shadings.

TO END THE TUTORIAL

After completing the tutorial session, click on **File**, then click on **Quit Riverine Module** to save the data entered or revised during the Tutorial and close the Demo1.xls Excel file. The BC Program will twice prompt the analyst to save any new data before closing the file and returning to the Excel 5.0 Opening Screen.

TO CONDUCT ANOTHER BCA

Use the mouse to move the cursor to **File**. Open the file, **RIVFD523.xls**, as described in the section, **OPENING FILES** on page 10. Under File, select Save As to save the BC Program under a different file name for the next model run.

C H A P T E R 5
BENEFIT-COST (BC) PROGRAM: GUIDANCE

Introduction

The accuracy, validity, and usefulness of a Benefit-Cost Analysis (BCA) depend on the correctness of the input data. A BCA in which input data such as the building depth-damage function or the effectiveness of the mitigation measure do not realistically reflect the particulars of the building and mitigation project under evaluation cannot provide useful results.

HELPFUL HINT
The computer software truism -
"GARBAGE IN, GARBAGE OUT"
also applies to BCAs of hazard mitigation projects.

Each analyst preparing a BCA has the responsibility to ensure that all data inputs are reasonable, defensible, and well documented. The program processes all of the data inputs in a mathematically correct manner, but the **Benefit-Cost (BC) Program cannot produce correct results when incorrect data are entered**. The analyst has control over the data inputs and thus, responsibility for the results.

Therefore, a good faith effort must be made to obtain accurate input data for BCA. The **First Floor Elevation (FFE)** of the building under evaluation is particularly important because this markedly affects the degree of flood risk to the building and thus markedly affects the benefits of avoiding future flood damages.

HELPFUL HINT

Each BCA must be reviewed to ensure that the data input is accurate and applicable to the building under evaluation.

Exact Data vs. Estimated Data

Despite the importance of accurate data, very few of the data inputs for BCAs for hazard mitigation projects will be exact numbers. However, if exact numbers are available for some of the data inputs, enter them. For example, if the **FFE**, the building square footage, and the value of contents are known, then enter the known values. In most cases, however, only a few of the required data inputs will be known exactly.

Typically, most of the data inputs for BCAs will be estimates, rather than exact numbers. If exact values are not available, it is acceptable to use approximate values or your best judgement. For example, if a neighborhood has houses of approximately 1,000 square feet and an average value of $60,000, then it is acceptable to use these values as the average for the neighborhood. It is **not** necessary to determine that one house has 927 square feet and another, 1,083 square feet, or that one house is worth $56,000 because the roof leaks and another is worth $62,500 because it has an elegant fireplace in the living room.

For most small projects, approximate values may provide an acceptable BCA. As project size (i.e., cost) increases, or for projects whose benefit-cost ratio (BCR) is very close to one, it may be worthwhile to devote more time and effort to obtaining better estimates or more exact values.

HELPFUL HINT

If exact data are not available, it is quite acceptable to use approximate data, reasonable estimates, or informed judgments.

Data Requirements

The level of detail, amount of data required, and level of effort necessary to conduct a BCA for a hazard mitigation project may vary substantially depending on the scale of the project and the desired accuracy of the analysis.

The BC Program software is flexible and is designed to accommodate different levels of analysis corresponding to different scales of projects and desired level of accuracy. The simplest analysis, requiring the least project-specific data, can be completed using "default" or reference data built into the program, along with a minimum amount of required project-specific data. More detailed analyses can, if desired, incorporate a large body of project-specific data.

Level One (Minimum Data) BCA

A **Level One (Minimum Data)** BCA can be conducted using "default" or reference data built into the program. See **Chapter 6, BC Program: Level One Analysis** for more detailed information.

HELPFUL HINTS:

The Level One Data entries MUST be completed whether or not a Level Two analysis is subsequently conducted. A Level One (Minimum Data) analysis may be appropriate for small, low-cost projects or as an initial screening of larger projects to assess whether more detailed analysis is warranted.

A Level One analysis is appropriate only if flood damages are due predominantly to water depth and not because of high velocity flow, debris or ice impacts, erosion, or soil failure.

A **Level One (Minimum Data)** analysis relies heavily on default data built into the BC Program. Completing a **Level One** BCA requires entering the following information:

All "required" data on the **Level One Data** screens, which include:

a) Project Information. These data, discussed in Chapter 6, page 47, identify the facility, the project under evaluation, and the discount rate. Except for the discount rate, these entries do not directly affect the numerical benefit-cost results.

b) Specification of the discount rate is discussed in **Chapter 6**, **BC Program: Level One Analysis**. The discount rate is fixed by the Federal Office of Management and Budget (OMB) and FEMA policy and is **NOT** a user-adjustable data variable for FEMA-funded projects. This entry should be checked for appropriateness. The appropriate rate for Section 404 or 406 Hazard mitigation projects is defined by OMB and updated annually.

c) **Building Data**. These data, which are discussed in Chapter 6, page 49, contain essential information, including the **FFE** of the building, and building replacement value.

d) **Building Contents**. These data, which are discussed in Chapter 6, page 53, identify the contents and the contents value.

e) **Displacement Costs Due to Flood Damage**. These data, which are discussed in Chapter 6, page 54, identify the cost of temporary building space and other costs associated with displacement from the building due to flood damage.

f) **Value of Public/Nonprofit Services**. These data, which are discussed in Chapter 6, page 56, describe the type of services provided, the daily

cost of providing these services from this building, the post-disaster continuity premium, and the total value of lost services per day.

g) **Rent & Business Income**. These data, which are discussed in Chapter 6, page 58, identify the total monthly rental income and estimated net business income of commercial tenants (if any).

h) **Mitigation Project Data**. These data, which are discussed in Chapter 6, page 59, specify the type of mitigation project, lifetime of the project, the total costs, and the effectiveness of the project in avoiding future damages and losses.

i) **Flood Hazard Data** on the "Flood Hazard" data entry screen. The required data on the "Flood Hazard" screen, discussed in Chapter 7, consist of information from the FEMA Flood Insurance Study (FIS): flood elevations and discharges for 10-, 50-, 100-, and 500- year floods. If a FIS is not available, then comparable data may be obtained elsewhere or estimated. In any case, good estimates of the flood hazard at the site under evaluation are essential for accurate BCAs.

HELPFUL HINT:

To conduct a Level One (Minimum Data) BCA:

1) Enter the required Level One Data.

2) Enter the Flood Hazard Data.

Level Two (Detailed) BCA

For large, high-cost projects, projects that are politically sensitive, or projects where initial screening indicates that BCRs are close to 1.0, a more detailed analysis may be desirable. Detailed analysis is also necessary whenever the default values, used in the **Level One (Minimum Data)** analysis, do not accurately reflect a specific project under evaluation. See **Chapter 8, BC Program: Level Two Analysis**, for a detailed discussion.

The **BC Program** allows the analyst to "override" (i.e., replace) any of the default values by entering building-specific data in the **LIGHT BLUE** data entry blocks. All entries in **LIGHT BLUE** blocks override default data which are always shown in **BROWN** blocks. Users may enter a complete building-specific analysis by entering data in all of the **LIGHT BLUE** blocks, or simply enter a few building-specific data where desired.

There are several circumstances when entering building-specific data is highly recommended, including:

1. For non-residential buildings, because the FIA depth damage data (see

Chapter 6) are predominantly for residential buildings.

2. Whenever high water velocities, debris, or ice flows are expected during flooding, because the default depth damage data are for damage resulting predominantly from water depth only.
3. For buildings which are unusually susceptible or resistant to flood damage because of construction details or contents.
4. For buildings in which loss of function impacts (displacement costs, rental and business income losses, loss of public/nonprofit services) are high.

For any large, high-cost, or politically sensitive projects, especially when a preliminary **Level One BCA** indicates a BCR near 1.0.

HELPFUL HINT

In conducting BCAs, the analyst has full control (and responsibility) for all of the data inputs that affect the BC results. None of the data input values are imposed by the BC Program.

Expediting BCAs

BCAs for a majority of the common hazard mitigation projects are easy and simple: many of the required data inputs are built into the software as default values and most of the other required data are readily obtainable.

There are **minimum** data collection requirements necessary to conduct BCAs. Some data, such as flood hazard information and **FFEs**, are particularly important for the analysis and accurate values must be obtained. Often the necessary data are not particularly difficult to obtain.

By providing a quantitative, defensible framework, BCAs for hazard mitigation projects may expedite the approval process for good projects by providing solid documentation of eligibility. A BCA may also reduce the appeal process for projects which are rejected by providing quantitative, rather than purely subjective decision-making criteria. Furthermore, if there are disputes between FEMA and applicants over the results of the BCA, all of the input data are clearly in the tables within the software for review and discussion.

Therefore, when the whole project evaluation process is considered, a BCA may actually reduce the effort required rather than increase it.

Furthermore, there are several ways to conduct benefit-cost analyses efficiently, including:

1. **Use common data to evaluate projects in a single neighborhood or area.** Many of the data may be applicable to numerous structures in an area. For example, flood elevations for the 10-, 50-, 100-, and 500-year floods may be applicable for a selected reach (i.e., length) of a stream. Other data inputs such as replacement value per square foot, depth-damage function, etc., may be the same or very similar for many structures in an area.
2. **Evaluate projects in an area consecutively.** To maximize the use of common data and for consistency, it may be desirable to conduct all the BCAs required for a given area consecutively, changing only the data that differ from project to project. Changes in only a small number of input parameters (or sometimes only one, such as the **FFE**) may facilitate the preparation of many analyses, once the first analysis is completed.
3. **Group (or aggregate) similar projects.** If a large number of structures are similar (such as a housing development), then it may not be necessary to conduct individual analyses of each structure. Rather, projects with the same flood hazard risk (i.e., at the same elevation or closely similar elevations) can be grouped or averaged. A buyout or relocation of one hundred 1,000 square foot houses can be analyzed as 100,000 square feet of single family residences, or analyzed by calculating the benefits for one (average) house, multiplied by one hundred, and then compared to the total cost of the buyout.
4. **Consider projects at the same or closely similar, FFE with the same flood hazard risk.** Flood hazard risk will be identical for structures at the same or closely similar **FFE** in the same area. Once the flood hazard information is compiled, many single analyses can be conducted using the flood hazard information, or groups of buildings at the same **FFE** can be grouped for one analysis.

   If a large number of similar structures at varying elevations are to be evaluated for a buyout, relocation, or for a single type of flood mitigation measure (e.g., elevation or protection by a levee), then structures may be grouped in bands (contours) of elevation. One or two feet of elevation difference can markedly change a flood hazard, so it is very important to group structures only of the same or closely similar FFEs and flood depths.

If a large group of structures varies in elevation, the structures may be grouped in one-foot elevation bands: for example, consider all structures between 6.5 and 7.5 feet of elevation to be at 7 feet. It should be noted that grouping structures in wide bands of elevation (e.g., covering several feet of elevation difference) will almost certainly produce substantially inaccurate results.

CAUTION:

Structures at different elevations cannot be grouped together because the flood hazard risk (i.e., the probability or recurrence interval of a given water depth) varies markedly with a building's FFE!

Use good judgement and make reasonable estimates. Remember that exact data are generally not available. Always use judgement and reasonable estimates whenever exact data are not available. Although it may be necessary to gather additional data for large (high-cost), controversial, high-visibility projects, or projects with BCRs near 1.0, many decisions related to cost-effectiveness will be clear and can be made with approximate data only.

Additional information and guidance for expediting BCAs can be found in a separate publication prepared by FEMA on the use of the Limited Data Module (RIVLD523.xls) and Very Limited Data Module (RVVLD523.xls). The publication is:

- **How to Determine Cost-Effectiveness of Hazard Mitigation Projects, A New Process for Expediting Application Reviews**, FEMA, Interim Edition, December 1996.

The above publication discusses screening of flood hazard mitigation projects to increase efficiency of BCAs and methods for using the above two modules when there is insufficient data to use the Full Riverine Data Module referenced in this manual.

Summary

The accuracy, validity, and usefulness of any BCAs depend on the correctness of the input data. A BCA in which **ANY** of the input data do not realistically reflect the particulars of the building and mitigation project under evaluation will be inaccurate and potentially misleading.

Many of the data inputs for BCAs are not exact numbers, but rather informed estimates or judgements. Nevertheless, all of the data inputs as well as the results must be reviewed for reasonableness and defensibility.

BCAs are subject to review and audit. Therefore, any analyses where the input parameters are not reasonable for the specific building and mitigation project under evaluation may be challenged.

HELPFUL HINT

ALL data inputs for a BCA MUST be reasonable and defensible. Otherwise, BC results will be invalid.

The analyst has control over the data, and thus responsibility for the results.

C H A P T E R 6
BENEFIT-COST (BC) PROGRAM: Level One ANALYSIS

Introduction

This chapter provides guidance on conducting a **Level One (Minimum Data)** Benefit-Cost Analysis (BCA); defines the data input terms; and provides hints on making reasonable estimates when exact data are not available. The **Level One Data** entries **MUST** be completed whether or not a **Level Two** analysis is subsequently conducted.

See **Chapter 3, Program Basics**, and **Chapter 4, Tutorial**, for basic information on moving around within data entry screens, entering data, erasing mistakes, etc. See an Excel 5.0 manual for detailed technical information about the spreadsheet program.

See **Chapter 5, Benefit-Cost (BC) Program: Guidance**, for general guidance on preparation of BCAs, including: the use of exact data vs. estimates, when to use **Level One (Minimum Data)** vs. **Level Two (Detailed)** BCA, and other helpful hints.

Data Differences: Public, Commercial, & Residential Buildings

The **BC** Program can be used to evaluate hazard mitigation projects for a wide range of building uses, including public/nonprofit, commercial, residential, and mixed-use buildings.

Generally, the data requirements are similar for different building uses. However, any data entries which are not applicable to the building under evaluation may be left blank or zeros may be entered. For example, in a completely public/nonprofit or residential building, leave blank or enter zeros for any entries which pertain to business income.

There are six types of avoided damages and losses (i.e., benefits) which are considered in the program: building damages, contents damages, displacement costs, business income losses, rental income losses, and lost public/nonprofit services. In some circumstances it may not be necessary to

consider all of these avoided damages and losses, even if they are applicable to the building under evaluation.

If a BCA is being used **ONLY** to establish minimum eligibility for funding and **NOT** to prioritize projects, then once sufficient benefits are considered to exceed the project costs, it may not be necessary to consider additional benefits. For example, if the benefits of only avoiding building damage exceed costs, then it may not be necessary to consider any of the other damages and losses avoided.

If desired, data can be entered sequentially. For example, enter data applicable to building damages only, then review the benefit-cost ratio (BCR) to see if it is greater than 1.0. If so, then other data entries can be left blank. If not, then contents damage data, displacement costs, etc., can be entered sequentially until benefits exceed costs, i.e., the BCR is greater than one. In other words, it may not be necessary to consider some of the more complicated damages and losses, such as the value of government services lost if projects can be demonstrated to be cost-effective by avoiding only building and contents damages.

However, if BCRs are used to prioritize among projects with BCRs greater than one, then it is important to fully count all of the benefits applicable to each project.

Data Input: Color Codes

Each entry is color coded. See Cell Colors, page 17, or **Model** and **Color Codes** on the BC Program menu.

User data entries can be made only in **DARK BLUE, GREEN, LIGHT BLUE,** or **PINK** blocks:

DARK BLUE Block	**OMB Policy**: entries determined by the Federal Office of Management and Budget (OMB) or FEMA policies and affect the numerical results.
GREEN Block	**Data Input**: entries affect the numerical results;
LIGHT BLUE Block	**Override Default Values**: entries affect the numerical results;
PINK Block	**Information Only**: entries do not affect the numerical results;

Blocks colored **BROWN, YELLOW,** and **PURPLE** and all other parts of the program are protected. User entries cannot be made in these blocks. To

change information in **PURPLE Blocks (Carry Over)** the original data entries in the **PINK** or **GREEN** blocks must be changed.

As you enter data, remember the color codes!

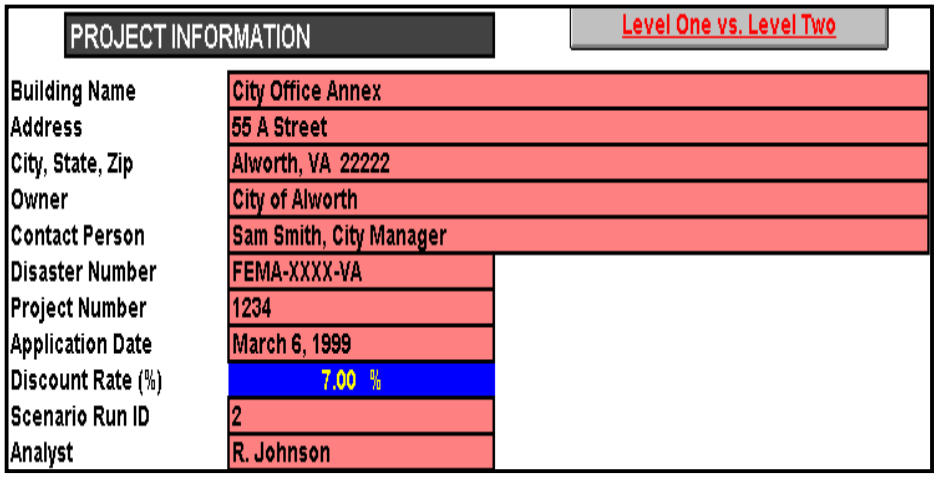
LEVEL ONE DATA

Introduction

To conduct a **Level One (Minimum Data) BCA**, only the **Level One Data** and the **FLOOD HAZARD Data** must be entered. To conduct a **Level Two (Detailed) BCA**, additional building-specific data may be entered. See **Chapter 5, BC Program: GUIDANCE**, for a discussion of the differences between **Level One** and **Level Two** analyses. See **Chapter 8, BC Program: Level Two Analysis**, for a detailed review of conducting a **Level Two** analysis.

Project Information

These data entries describe the building and hazard mitigation project under evaluation.



Level One vs. Level Two Button

This button provides information, as a reminder to the analyst, regarding the differences between Level One and Level Two Analyses.

Building, Name, Address, City, State, Zip

PINK Blocks (Information Only). These entries contain basic identifying information about the building being evaluated: **Building Name, Address, City, State, and Zip Code**.

Owner	**PINK Block (Information Only).** The building's **Owner** may be an agency, a private party, etc. Building ownership may affect eligibility for hazard mitigation funding.
Contact Person	**PINK Block (Information Only).** The **Contact Person** is someone who could, if needed, provide additional information about the building to the analyst.
Disaster Number	**PINK Block (Information Only).** The **Disaster Number** is a unique number assigned by FEMA for each disaster. This data is entered as FEMA-xxxx-DR-ST (where "xxxx" represents the FEMA disaster number and "ST" is the two character abbreviation for the state.
Project Number	**PINK Block (Information Only).** The **Project Number** may be the DSR number assigned by FEMA or another identifying number assigned by the analyst.
Application Date	**PINK Block (Information Only).** The **Application Date** is the date when the application was submitted to FEMA.
Discount Rate (%)	**DARK BLUE Block (OMB Policy).** The **Discount Rate** entry is determined by OMB/FEMA policy and cannot be varied by the user on a project-by-project basis. On October 29, 1992, OMB issued Circular A-94, Revised (Transmittal Memo No. 64), "Guidelines and Discount Rates for BCA of Federal Programs." In this Circular, OMB states that the appropriate discount rate varies depending on whether or not the investment (i.e., project) is an "internal Federal government investment." For FEMA-funded hazard mitigation projects for state and local governments (or eligible nonprofits), the OMB-mandated discount rate is the rate applicable for investments which are **not** internal Federal government investments. The OMB-mandated discount rate corresponds approximately to the 30-year Treasury bond rate, but the appropriate rate is specifically fixed by OMB annually. Currently, the OMB-mandated discount rate is 7% (see Appendix C of Circular A-94). For each disaster, an appropriate discount rate should be determined by FEMA, in accordance with the OMB guidance, and applied **uniformly** to all hazard mitigation projects being considered. The discount rate determined for each disaster is entered in the **DARK BLUE Block**. After this rate is determined and entered **ONCE**, it can then be used for analysis of **ALL** hazard mitigation projects for this disaster.

HELPFUL HINT

The discount rate is determined by OMB Guidance and is NOT a user-defined parameter for FEMA-funded projects.

Scenario Run ID

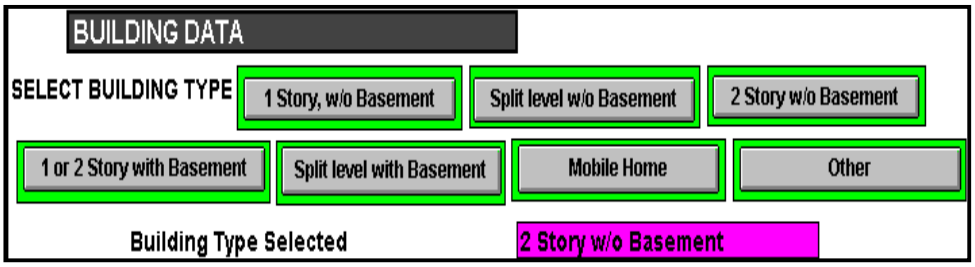
PINK Block (Information Only). The **Scenario Run ID** provides a place to enter a Run Number or identifying name to distinguish this particular BCA from other model runs. In some cases, multiple analyses of the same project may be run with different sets of input assumptions to explore the sensitivity of results to changes or uncertainties in input data.

Analyst

PINK Block (Information Only). The **Analyst** block identifies the person principally responsible for the BCA. The analyst's name is displayed automatically in small type on the bottom of each printed page and on the cover page of the printed report.

Building Data

Select Building Type



The building construction type is very important for the BCA because many of the numerical values in the program, including the amount of damage a particular building type is expected to sustain under different flood depths, depend on the building type.

GRAY Button (Data Input). Select the **Building Type** by clicking on the appropriate **gray button with green background** that applies. This entry determines many of the default parameters. The selected building type appears in the **PURPLE Block** labeled **"Building Type Selected."**

The building types on the **Select Building Type** buttons are the six Federal Insurance Administration (FIA) building types. If one of these six types is

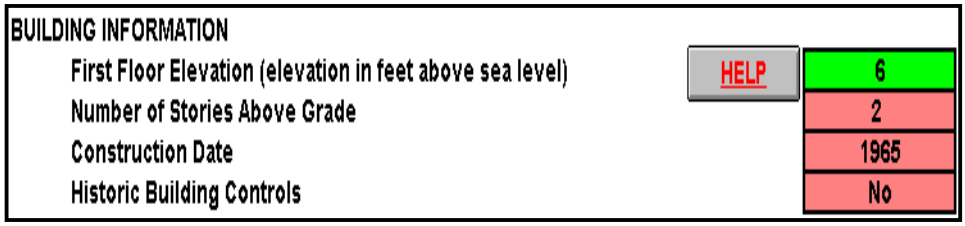
selected, default depth-damage functions are used by the program to estimate flood damages. To view the default depth-damage function for the building type selected, choose **Level Two Data | Building Depth-Damage Function** from the program menu, or see the Default Depth-Damage Function Table on page 73.

If the building under evaluation is not one of these FIA types, then a **Level Two** analysis of the Building Depth-Damage Function **MUST** be done. The closest type building type may be selected to provide a depth-damage function for reference, but a building-specific depth-damage function appropriate for the building **MUST** be entered.

See **Chapter 8, BC Program: Level Two Analysis**, page 85, for information about entering building-specific depth-damage functions. If **Other** is selected for building type, no default depth-damage functions can be provided for a **Level One** analysis and a **Level Two** analysis **MUST** be conducted for the **Building Depth-Damage Function AND** for the **Contents Depth-Damage Function**.

Building Information

This section contains entries for the depth above **First Floor Elevation (FFE)** and three descriptive categories for the building.



First Floor Elevation (FFE)

GREEN Block (Data Input). The **FFE**, as defined by the FIA, is the elevation in feet of the **top** of the finished flooring of the lowest finished floor, not including basements or crawl spaces. Elevation units are in feet above sea level

The **FFE** of the building under evaluation is particularly important because it markedly affects the degree of flood risk for the building, and thus markedly affects the benefits of avoiding future flood damages.

The **FFE** can be obtained from surveyed elevation data if available, or may be estimated from observed flood data. For example, if the flood was known to have had an elevation of 463 feet in an area and the flood depth in a building was 4.5 feet above the FFE**,** then the **FFE** for the building (i.e., the elevation of the top of the finished flooring of the lowest finished floor) must be 458.5 feet.

Number of Stories Above Grade

PINK Block (Information Only). The **Number of Stories Above Grade** may affect engineering judgment about the building's vulnerability to flood damage. Taller buildings will have lower percentages of flood damage at a given flood depth because only the lower story or stories will be directly affected by flood waters.

Construction Date

PINK Block (Information Only). The **Construction Date** is included to provide guidance about the building's vulnerability to flood damage because construction practices change with time. In the absence of more detailed information, knowing the construction date may help a knowledgeable engineer to make informed judgements about probable construction materials and details which may be relevant to the building's depth-damage function.

Historic Building Controls

PINK Block (Information Only). Enter a "**YES**" or "**NO**" in **Historic Building Controls** to indicate whether this building has been entered or is eligible to be entered in the National Register of Historic Buildings, or is affected by any similar legislation. Historic status may limit allowable flood hazard mitigation projects and result in higher than normal costs for both flood damage repair and mitigation projects.

Building Size and Use

Total Floor Area (sf)

GREEN Block (Data Input). The **Total Floor Area** in square feet (sf) is the size of the entire building. This is equal to the product of the building footprint and the number of stories above ground. The total floor area does not include basement or crawl space area.

Area Occupied by Owner or Public/Nonprofit Agencies (sf)

GREEN Block (Data Input). The **Area Occupied by Owner or Public/Nonprofit Agencies (sf)** may be the same as the total area or less if commercial businesses occupy part of the building. For single family residences, the total area and area occupied by the owner are generally the same.

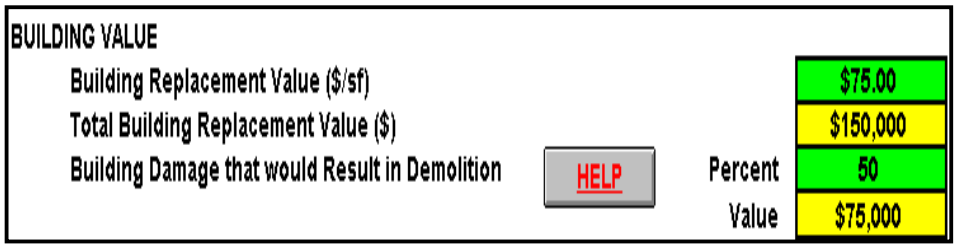
These two areas are distinguished because some of the economic data (displacement costs, rental and business income, value of public/nonprofit services) depend on the space occupied by public/nonprofit agencies and commercial businesses.

HELPFUL HINT

Both "area" data entries must be completed because building replacement value depends on the first value, while displacement costs and the value of public/nonprofit services depend on the second value.

Building Value

The data entries in these blocks describe several aspects of the value of the building.



Building Replacement Value ($/sf)

GREEN Block (Data Input). Building Replacement Value ($/sf) is a measure of the economic value of the building, including the structural and non-structural permanent parts of the building, but excluding contents.

Replacement value means the cost to provide a functionally-equivalent structure of the same size. Replacement value does not include recreating historical or archaic materials, finishes, or features.

For historic buildings, the distinction between "reproduction" and "replacement" value may be important. Reproduction duplicates the design and architectural details of a specific building. For historic buildings, the reproduction value rather than the replacement value may be a more appropriate measurement of a building's value. If desired, an historic building's reproduction value (in $/sf) can be entered in the "**Building Replacement Value**" block.

Total Building Replacement Value ($)

YELLOW Block (Result). Total Building Replacement Value ($) is the product of the value per square foot and the total floor area.

Building Damage that would Result in Demolition (%)

GREEN Block (Data Input). Building Damage that would Result in Demolition, the "demolition threshold," is the percentage of building damage at which demolition and replacement (rather than repair) would be expected to occur as the economically efficient choice. Many buildings will be demolished rather than repaired when the cost to repair the damage exceeds some percentage of the replacement cost.

HELPFUL HINT

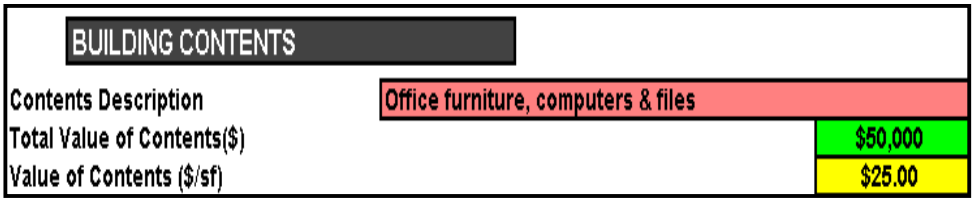
The Demolition Threshold Percentage MUST NOT be set at zero or left blank because doing so would cause the Modified Building Depth-Damage Function to be 100% at all flood depths. This unrealistic data input would produce substantially distorted and invalid BC results.

For older, somewhat substandard buildings, the demolition threshold may be quite low (e.g., 20% or 30%). For typical, relatively modern buildings, the threshold will generally be higher (e.g., 50% or 60%). For some particularly important historical buildings, the demolition threshold may approach 100%.

The demolition threshold damage percentage is an important policy parameter which may significantly affect the Benefit-Cost (BC) results because it may have a major impact on the depth-damage function. Therefore the demolition threshold damage percentages should be chosen carefully in accord with the condition and viability of the existing building. For example, a brand new city hall building would probably be repaired from a higher level of damage than would a decrepit building badly in need of refurbishing.

YELLOW Block (Result). The demolition threshold in dollars of damage is calculated from the entered percentage and the building replacement value.

Building Contents



Contents Description

PINK Block (Information Only). The **Contents Description** block is for a brief summary of the building's contents (e.g., computers, office furniture).

Total Value of Contents ($)

GREEN Block (Data Input). Total Value of Contents is the estimated total value of the building's contents, including furniture, carpet, equipment, computers, supplies, etc.

The exact value of building contents is rarely known. Estimates can be obtained from owners, or from a general knowledge of the nature of the contents and common sense. For example, an art museum or a building filled with computers will have a much higher contents value than a building storing used bricks or recycled newspapers.

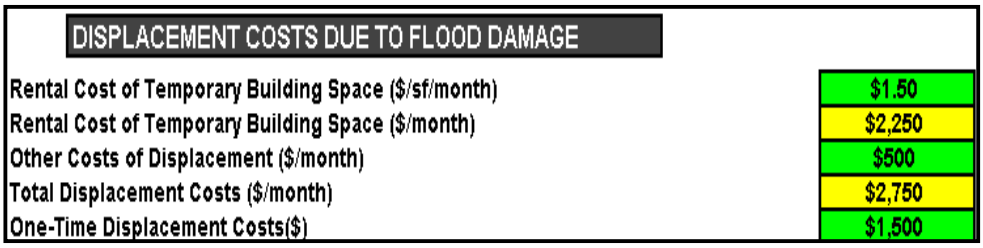
For most buildings, the value of contents is significantly smaller than the building value. However, in some cases where contents are unusually valuable (e.g., an art museum or an auto dealership) or usually vulnerable to flood damages, then avoiding contents damage may be as important or more important than avoiding building damages in determining total project benefits.

Default estimates of the **Contents Depth-Damage Function** (i.e., contents damage as a percentage of total contents value) are based on the building type selected. To view the default contents depth-damage function for the building type selected, choose **Level Two Data | Contents Depth-Damage Function-BEFORE** from the BC Program menu; for more information see page 79.

Value of Contents ($/sf)

YELLOW Block (Result). The **Value of Contents ($/sf)** is calculated from the **Total Value of Contents** and the **Total Floor Area** of the building. The **Value of Contents ($/sf)** may be useful in comparing contents values from building to building and as a guide as to whether estimated contents values are reasonable.

Displacement Costs Due to Flood Damage



Displacement Costs due to Flood Damage may be incurred when occupants must operate from a temporary site while flood-related damage to the original building is repaired. Costs for temporary rent and other displacement expenses are entered here.

Rental Cost of Temporary Building Space ($/sf/month)

GREEN Block (Data Input). Rental Cost of Temporary Building Space ($/sf/month) is an estimate of the rental rate paid for temporary quarters. Major floods may cause extensive damage to many structures, thus reducing the available supply of alternate space and leading to higher rental costs throughout the area.

Rental Cost of Temporary Building Space ($/month)

YELLOW Block (Result). The **Rental Cost of Temporary Building Space ($/month)** is calculated from the **Area Occupied by Owner or Public/Nonprofit Agencies (sf)** and the **Rental Cost of Temporary Building Space ($/sf/month)**.

Other Costs of Displacement Costs ($/month)

GREEN Block (Data Input). Other Costs of Displacement ($/month) include moving and extra operating costs incurred because of the disruption and displacement from normal quarters.

Total Displacement Costs ($/month)

YELLOW Block (Result). Total Displacement Costs ($/month) are calculated as the sum of **Rental Cost of Temporary Building Space ($/month)** and **Other Costs of Displacement ($/month)**.

One-Time Displacement Costs ($)

GREEN Block (Data Input). One-Time Displacement Cost ($) is a lump sum amount which is the cost of being displaced. This cost includes moving expenses, replacement costs for clothing and personal items, costs for transferring utility services, etc.

Default estimates of displacement times depend on building damages at each flood depth. To view the default displacement time estimates choose **Level Two Data: Displacement Time** from the BC Program menu. For more information, see page 81.

Displacement costs for tenants are approximated in the BC Program by counting the rental income losses to the owner. Counting tenant displacement costs and rental income losses would be double counting.

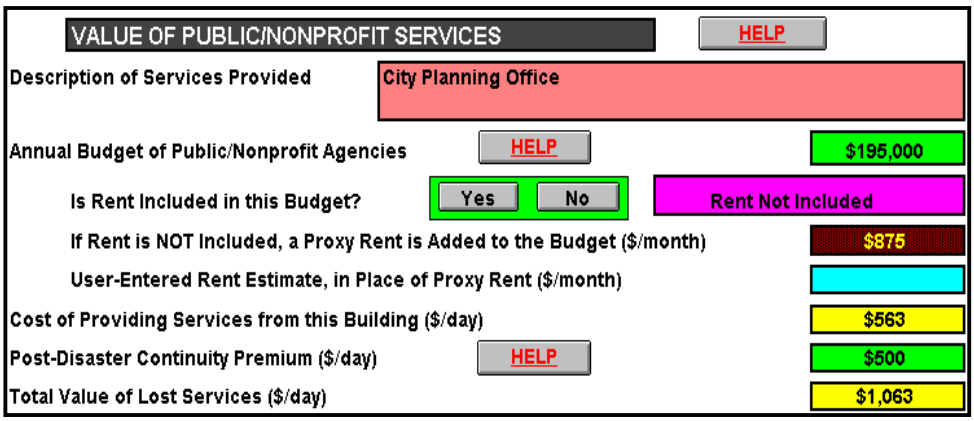
For public/nonprofit agencies, **Displacement Time** is distinct from **Functional Downtime** (i.e., service interruption); estimates for each will generally be quite different. For example, a public agency which is relocated in temporary quarters for six months will incur six months of displacement costs, but the loss of service is only two weeks if the agency is functioning in temporary quarters two weeks after the flood. To view the Default Functional Downtime estimates, choose **Level Two Data | Functional Downtime-BEFORE** from the BC Program menu; or see page 86.

Value of Public/Nonprofit Services

To Bypass This Section

This section applies **ONLY** to public/nonprofit service facilities. If the building under evaluation is a commercial or residential building, then bypass this section. To ensure that spurious numbers are not included in the calculation, leave all entries in this section (**Value of Public/Nonprofit Services**) blank or enter zeros and move to the next section, **Rent & Business Income**.

The value of public/nonprofit services is included in the BC Program to count fully the benefits of avoiding flood damage for such facilities.



Description of Services Provided

PINK Block (Information Only). This block provides a place to enter a brief summary of the type of services provided from this location.

Annual Budget of Public/Nonprofit Agencies

GREEN Block (Data Input). The **Annual Budget of Public/Nonprofit Agencies** is the total annual operating budget of all the public/nonprofit agency functions located in this building. The total should **include** rental costs but **exclude** "pass-through" monies (e.g., Social Security payments) which the agency receives and redistributes. The annual operating budget is used to estimate the value of services provided. For example, if a public/nonprofit agency spends $10,000 per day providing a service to the public, then this service is valued at $10,000 per day and the loss of this service due to flood damage is also valued at $10,000 per day.

Is Rent Included in this Budget?

GRAY Buttons with Green Background (Data Input). Select whether the **Annual Budget** includes or excludes any rent paid (by an agency which does not own the structure) by clicking on the appropriate button. The choice will be displayed in a purple box next, to the rent buttons.

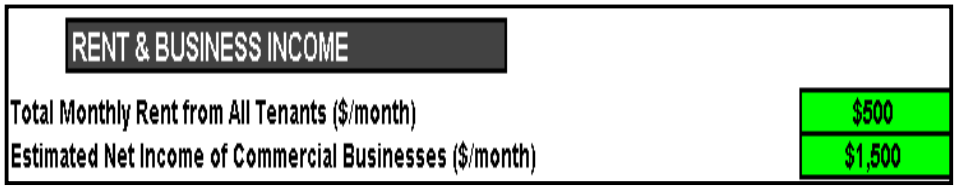
Proxy Rent	**BROWN Block (Default)**. If rent is **NOT** included in the annual budget, the program calculates a default or proxy rent based on the value of the building and the discount rate.
User-Entered Rent Estimate ($/month)	**LIGHT BLUE Block (Override Default).** If rent is **NOT** included in the annual budget, **AND** if the proxy rent displayed is **NOT** a reasonable estimate for the building under evaluation, then enter a **User-Entered Rent Estimate in place of Proxy Rent ($/month)**.
Cost of Providing Services From This Building ($/day)	**YELLOW Block (Result).** The program calculates the daily **Cost of Providing Services from this Building ($/day)** based on the annual budget and, if rent is not included in the annual budget, from the default proxy rent or, if provided, from the user-entered rent estimate.
Post-Disaster Continuity Premium ($/day)	**GREEN Block (Data Input).** Some public/nonprofit services may be not be in demand after a disaster, while others may be vital to maintain the community. Public/nonprofit services that are important for post-disaster response and recovery are worth more to the community after the disaster than in normal circumstances. The **Post-Disaster Continuity Premium ($/day)** is a way of assigning an extra value to these post-disaster services. For example, emergency services would be vital in the hours and days immediately following a disaster, whereas routine services such as employment referral would not. Based on the nature of the services in this building, the continuity premium is how much **extra** daily cost the tenant agencies would be willing to spend to maintain agency functions after a disaster. The magnitude of the **Post-Disaster Continuity Premium** depends on how critical the services are in the post-disaster environment. Emergency response services such as medical, fire, and police are particularly important post-disaster and continuity premiums for such services are generally high. Services which are only moderately important during a post-disaster situation should have moderate premiums. Routine services that can be delayed with little or no impact should not have continuity premiums. Continuity premiums of 50 to 100% of the normal daily costs of providing services may be appropriate for services which are moderately important in the post-disaster environment. Continuity premiums of several times normal daily costs may be appropriate for emergency response services. Continuity premiums of five or ten times the normal daily costs may be appropriate for services which are critical to the disaster response. The **Post-Disaster Continuity Premium**, like all other inputs for the Benefit-Cost Analysis (BCA), must be reasonable and defensible for the specific public/nonprofit service being valued. If the continuity premium is unreasonable, this portion of the analysis will be invalid.

Total Value of Lost Services ($/day)

YELLOW Block (Result). The **Total Value of Lost Services ($/day)** is calculated by summing the daily cost of providing services under normal conditions and the **Post-Disaster Continuity Premium**.

Estimates for the value of lost public/nonprofit services for each flood depth are based on the daily cost of providing services and estimates of **Functional Downtime**. **Functional Downtime** is the time period for which public/nonprofit services are lost due to flood damage. Default estimates of **Functional Downtime** are based on the building depth-damage function. To view the default **Functional Downtime** estimates choose **Level Two Data | Functional Downtime** from the BC Program menu; or see page 84.

Rent and Business Income



Total Monthly Rent From All Tenants ($/month

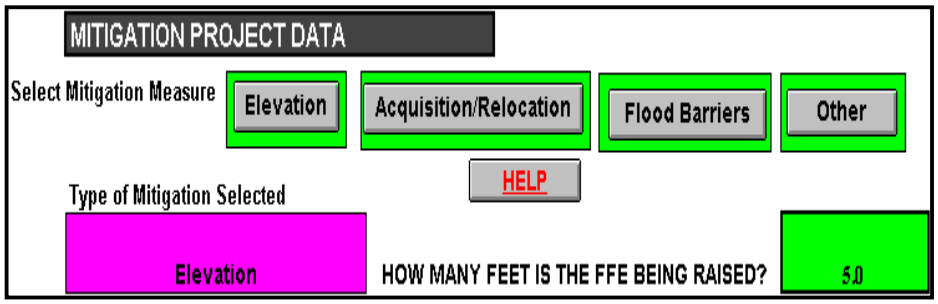
GREEN Block (Data Input). Total Monthly Rent ($/month) entered here is the amount paid by all tenants in the structure. For a commercial or residential building which is rented, this amount is included to value the loss of rental income from flood damages. For a public/nonprofit building, the rent value entered should be only the rent for that portion, if any, rented to private tenants. Rent costs for public/nonprofit agencies are included in the **Value of Public/Nonprofit Services** section discussed above.

Estimated Net Income of Commercial Businesses ($/month)

GREEN Block (Data Input). Estimated Net Income of Commercial Businesses ($/month) is the net, **not gross**, income per month of commercial businesses in the building. Exact figures will generally not be available, so reasonable estimates may be made. If there are no commercial businesses in the building, then leave this entry blank or enter a zero.

Mitigation Project Data

Select Mitigation Measure



GRAY Buttons (Data Input). Select the mitigation measure by clicking on the appropriate gray button with green background. Select one of the four possible mitigation measures:

1. Elevation
2. Acquisition/Relocation
3. Flood Barriers
4. Other

An explanation of the data requirements or assumptions for the mitigation measures can be viewed through the adjacent Help button.

If the Elevation button is selected, the analyst must enter the number of feet above the building will be raised above the current FFE.

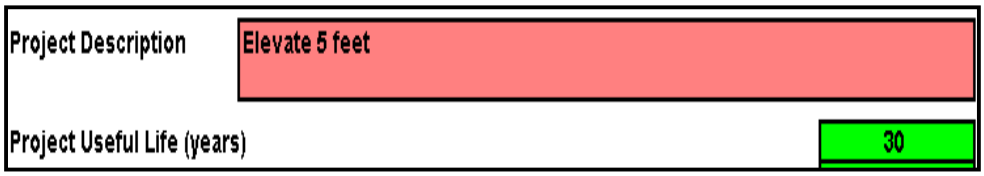
If the Flood Barrier (i.e., levee, floodwall, or dry floodproofing) is selected, the analyst must also enter the elevation of the Top of the barrier (in feet above sea level). Do not enter the height of the flood barrier. This data will be referenced to the flood hazard information to determine the effectiveness, or level of protection, of the mitigation project.

Type of Mitigation Selected

The type of mitigation measure selected appears in the purple block and will be carried forward to the summary and report areas of the BC Program.

How Many Feet Is The FFE Being Raised

If appropriate for the mitigation project selected, enter the number of feet that the **First Floor Elevation (FFE)** is being raised for this project in the green box.



Project Description

PINK Block (Information Only). This space is provided to enter a brief summary of the proposed mitigation project, for example, "buyout of 10 homes," "relocate 25 homes," or "elevate the home 10 feet."

Project Useful Life (years)

GREEN Block (Data Input). The project useful life is the estimated number of years during which the mitigation project will maintain effectiveness. Useful life is the time period over which the estimated economic benefits of the proposed mitigation project are counted. The useful life which the user enters **MUST** be commensurate with the actual project being considered.

Useful lives of 5 to 10 years for equipment purchases, and 30 (residential) to 50 (non-residential) years for building projects are typical. For major infrastructure projects, or for historically important buildings, useful lives of 50 to 100 years may be appropriate. For buyouts/relocations, a lifetime of 100 years will fully capture the benefits of the mitigation measure.

Mitigation Effectiveness

Elevation

Elevating buildings by **N** feet is generally 100% effective to **N-1** feet. For example, elevating 8 feet is 100% effective to 7 feet, elevating 12 feet is 100% effective to 11 feet. This result is due to the fact that, for example, an "8-foot flood" is considered in the program to be all floods between 7.5 and 8.5 feet. Therefore, elevating a structure 8 feet will convert an 8-foot flood into a 0-foot flood (from -0.5 to 0.5 feet), and there is still damage from a 0-foot flood. Thus, an 8-foot elevation is 100% effective to only 7 feet.

	For buildings with basements, the situation can be more complicated depending on the degree of flood proofing of the basement. Unless there is detailed information available about an individual structure, assuming that elevating N feet is 100% effective to N-1 feet is a reasonable assumption for structures with and without basements. This assumes that flood proofing of the basement occurs along with elevation. The flood depth at which elevations are 0% effective is calculated automatically by the program and need not be entered by the user.
Relocation/Buyout	Relocation/Buyout projects are assumed to be 100% effective at all flood depths and thus effectiveness depths need not be entered by the user.
Flood Barriers	The flood depth at which flood barriers are 100% and 0% effective depends on how the barrier is constructed and on assumptions about freeboard. Freeboard is defined as the height of a flood barrier above a flood height which is necessary to insure satisfactory flood performance. For example, to provide 100-year flood protection for flood insurance purposes levees must be constructed 3 feet above the 100-year flood elevation (i.e., with 3 feet of freeboard). In the absence of detailed engineering analysis, a simple assumption about flood barriers is that a flood barrier of height **N** feet is 100% effective to **N-1** feet and 0% effective at **N** feet.
Other	Other flood hazard mitigation projects include wet flood proofing and any other measures not covered by the three mitigation types discussed above. The depths at which "Other" flood hazard mitigation projects are 100% and 0% effective must be estimated on a case-by-case basis. The Benefit-Cost (BC) Program calculates project effectiveness for only the selected mitigation project type. Other entries should be deleted to avoid confusion; however, the program ignores any other values in the table. The effectiveness of flood hazard mitigation projects at every flood depth is calculated by the program from the depths of 100% and 0% effectiveness.

Mitigation Project Costs

Mitigation Project Costs (excluding relocation costs)

Mitigation Project Cost (excluding relocation costs)	$40,000
Base Year of Costs	1999
Annual Maintenance Costs ($/year)	$500
Present Value of Annual Maintenance Costs ($)	$6,205
Relocation Costs for Mitigation Project	
Relocation Time Due to Project (months)	2
Rental Cost during Occupant Relocation ($/sf/month)	$2.00
Rental Cost during Occupant Relocation ($/month)	$3,000
Other Relocation Costs ($/month)	$500
Total Relocation Costs	$7,000
Total Mitigation Project Costs	$53,205

GREEN Block (Data Input). The **Mitigation Project Cost** includes all direct construction costs plus other costs such as architectural and engineering fees, testing, permits, and project management, but **excludes relocation costs**.

Base Year of Costs

PINK Block (Information Only). The **Base Year of Costs** is the year in which the mitigation project's costs were estimated. If cost estimates are several years old, they may need to be adjusted by the analyst to account for inflation in costs between the base year and the present.

Annual Maintenance Costs ($/year

GREEN Block (Data Input). Annual Maintenance Costs ($/year) may be required to maintain the effectiveness of some mitigation projects, particularly levees where annual inspection and vegetation removal may be required. For most other mitigation projects, **Annual Maintenance Costs** will be negligible or zero.

Present Value of Annual Maintenance Costs ($)

YELLOW Block (Result). Based on the discount rate, the **Annual Maintenance Cost** for each year of the project useful life is reduced to its present value and summed.

Relocation Costs for Mitigation Projects

For some mitigation projects, occupants may have to be relocated for construction of the project. In such cases, the **Relocation Costs** are an integral part of the mitigation project and must be counted in the total mitigation project costs.

Relocation Time Due to Project (months)

GREEN Block (Data Input). Relocation Time Due to Project (months) is the number of months for which the building must be vacated **in order for the mitigation project to be completed**. Note that this relocation time is completely distinct from the displacement time needed to repair flood-related damages.

Rental Cost during Occupant Relocation ($/sf/month)	**GREEN Block (Data Input). Rental Cost During Occupant Relocation ($/sf/month)** is an estimate of the rental rate paid for temporary quarters. Major floods may cause extensive damage to many structures, thus reducing the available supply of temporary space and leading to higher rental costs throughout the area.
	YELLOW Block (Result). Rental Cost During Occupant Relocation ($/month) is the product of the **Rental Cost ($/sf/month)** and the **Total Floor Area (sf)**.
Other Relocation Costs	**GREEN Block (Data Input). Other Relocation Costs ($/month)** include moving and extra operating costs incurred because of the temporary relocation.
Total Relocation Costs	**YELLOW Block (Result).** The **Total Relocation Costs** are calculated from the entered **Relocation Time Due to Project (months)**, **Rental Cost During Occupant Relocation ($/month)**, and **Other Relocation Costs ($/month)**.
Total Mitigation Project Costs	**YELLOW Block (Result). Total Mitigation Project Costs** are calculated by summing the **Mitigation Project Cost**, the **Present Value of the Annual Maintenance Costs**, and the **Total Relocation Costs**.
Next Screen	This completes the **Level One (Minimum Data) BCA** data entry process except for the **Flood Hazard** data. To enter **Flood Hazard** data, click on the Next Screen button at the bottom of the second **Level One Data** page, or select **Flood Hazard** from the BC Program menu.

C H A P T E R 7
BENEFIT-COST (BC) PROGRAM: FLOOD HAZARD ANALYSIS

Introduction

Level One Analysis

This section contains data entries for flood frequencies, discharges and elevations that are necessary to specify quantitatively the extent of flood hazard at The site under evaluation. From the entered flood data, the program calculates the expected annual number of floods in one-foot elevation increments. "Expected" refers to the long term statistical average number per year, not that this number of floods occurs every year.

The degree of flood risk at a particular site profoundly affects the expected flood damages at a site and thus profoundly affects the benefits of avoiding flood damages at the site. Therefore, the flood hazard data entered in this section are among the most critical data inputs for Benefit-Cost Analysis (BCA) of flood hazard mitigation projects.

HELPFUL HINTS:

Entering incorrect flood frequency, discharge, and elevation data will result in incorrect flood probabilities and thus yield INVALID BC RESULTS.

A Level One Analysis of Flood Hazard Risk requires a FIS and a FIRM, or equivalent information, for the location and FEMA flood data for the site under evaluation.

Level Two Analysis

If a Flood Insurance Study (FIS) and a Flood Insurance Rate Map (FIRM) are not available, or if the user desires to use other estimates of flood hazard risk, then a **Level Two** Analysis must be performed.

FLOOD HAZARD RISK

Carry Over Information

PURPLE Blocks (Carry Over). Information from the **Level One DATA** page is displayed to identify the building under consideration and to provide reference information and guidance for **Level Two (Detailed)** evaluations.

FLOOD HAZARD DATA

FLOOD HAZARD DATA

Data from Flood Insurance Study (FIS)

Flood Frequency (years)	Discharge (cfs)	Elevation (ft)
10	279,000	5.3
50	361,000	7.4
100	377,000	8
500	444,000	9.5

Flood frequency, discharge and elevation data **MUST** be entered in the flood hazard table in order to calculate the degree of flood risk at the site under evaluation. Flood data for 10-, 50-, 100-, and 500-year floods are generally available from the FIS for the area under evaluation. However, if flood data for other frequencies are available, the frequencies and corresponding discharge and elevation data may be included in this table.

The table showing the expected annual number of floods is automatically recalculated whenever the flood data are revised.

Flood Discharge Data

The FIS contains a table of flood frequencies and discharges similar to the two left columns of the table above. If more than one set of discharge data is shown for the stream, use the discharges for the nearest discharge point to the building location.

Flood Elevation Data

The FIS also contains **Flood Profile** plots that show the elevations of 10-, 50-, 100-, and 500-year floods along the stream. The elevation of a 100-year flood, for example, varies with location along the stream because water runs downhill. To characterize flood risk at a given location, it is necessary to know the elevation of the 10-, 50-, 100-, and 500-year floods **at this location**. These data may be obtained from the **Flood Profile** plots in the FIS.

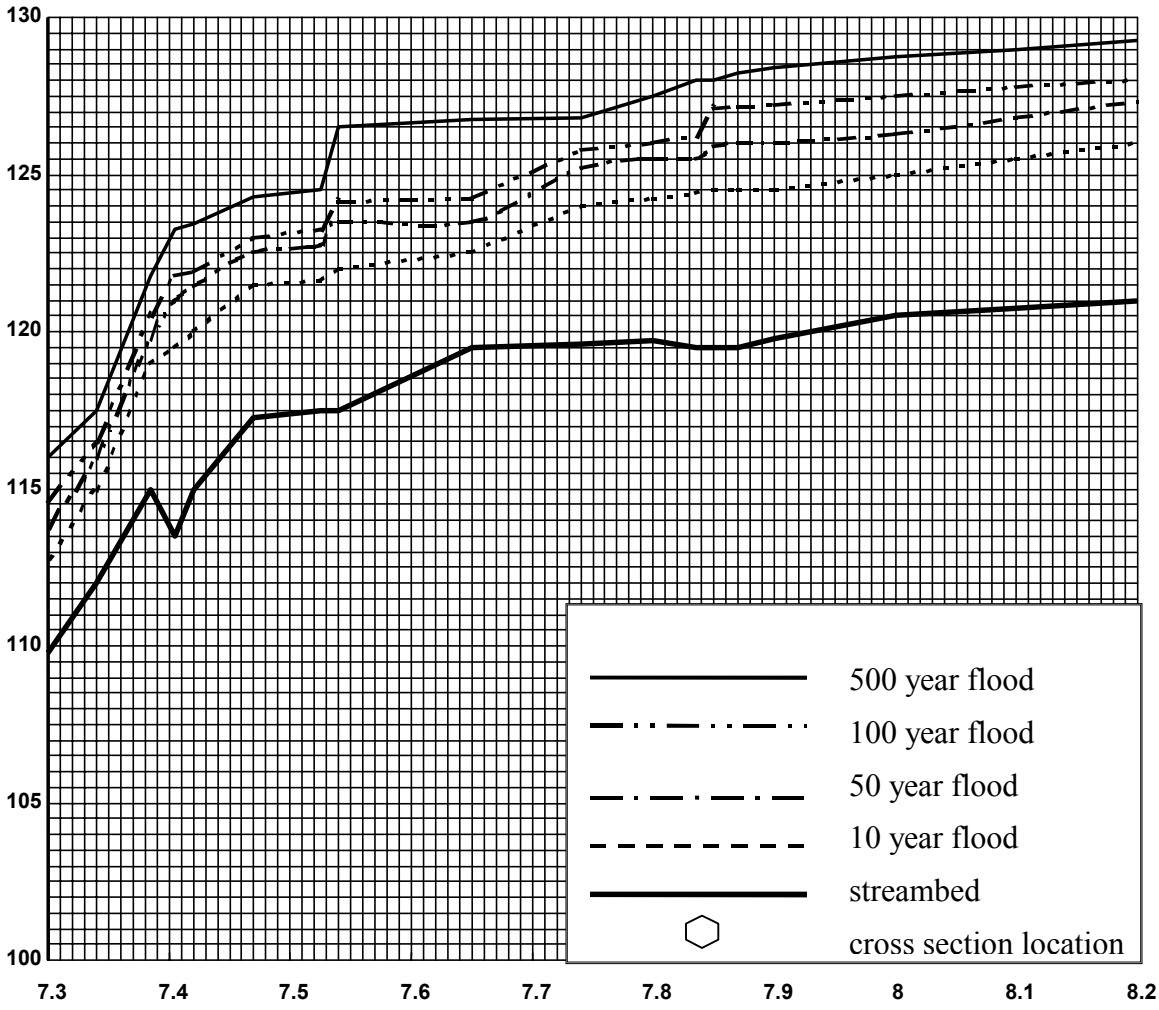
Flood Profile plots show the variation of flood elevations with distance upstream from a waterway confluence, bridge, or street crossing. To determine the elevations for the building under evaluation, the distance upstream from a landmark on the Flood Profile plot must be measured on a map. The Flood Insurance Rate Map (FIRM) may be used for this purpose. Once the location has been properly identified, then flood elevations for the 10-, 50-, 100-, and 500-year floods are read from the Flood Profile plot.

An example of a Flood Profile plot from an FIS is shown on the following page. In this example, stream distance is shown in thousands of feet above the confluence with Overpeck Creek. The house under evaluation is located about 7,850 feet above the confluence, or 45 feet upstream from the Vanostrand Avenue crossing. Flood elevations for the 10-, 50-, 100-, and 500-year floods are read from this section of the Flood Profile plot.

In this example, the 500-year elevation is 128.1 feet; the 100-year elevation is 127.1 feet; the 50-year elevation is 125.9 feet; the 10-year elevation is 124.5 feet; and the channel bottom is 119.5 feet.

Flood elevations may vary markedly along the stream course depending on the gradient of the individual stream. Therefore, it is very important to properly read the flood elevation data on the Flood Profile plot for the specific site under evaluation.

EXAMPLE FLOOD PROFILE GRAPH



STREAM DISTANCE IN THOUSANDS OF FEET ABOVE CONFLUENCE W/OVERPECK CREEK

HELPFUL HINT:

Entering incorrect flood discharge and flood elevation data will result in incorrect flood probabilities and thus INVALID BC RESULTS.

For additional guidance on obtaining flood information from FISs and FIRMs, users are referred to the following publications:

1. **Guide to Flood Maps** (FEMA 258), May 1995.
2. **Flood Proofing, How To Evaluate Your Options**, US Army Corps of Engineers, 1993.
3. **Engineering Principles and Practices for Retrofitting Flood Prone Residential Buildings** (FEMA 259), January 1994.
4. **Homeowners Guide to Retrofitting; Six Ways to Protect Your House From Flooding** (FEMA 312), June 1998.

Expected Annual Number of Floods

Expected Annual Number of Floods by Flood Depth

EXPECTED ANNUAL NUMBER OF FLOODS

Flood Depth (feet)	Default Value	User - Entered Value
-2	5.321E-01	
-1	1.336E-01	
0	4.926E-02	
1	2.072E-02	
2	1.225E-02	
3	3.691E-03	
4	1.223E-03	
5	4.497E-04	
6	1.801E-04	
7	7.753E-05	
8	3.547E-05	
>8	3.630E-05	

Default Flood Estimates

The default estimates of the **Expected Annual Number of Floods** of each flood depth from -2 to +8 feet or greater are shown in the **BROWN**

(Default) column. These estimates are calculated from the flood frequency, discharge and elevation data entered previously. "Expected annual number" of floods does not mean that this number of floods occurs every year, but rather "expected" indicates the long term statistical average number of floods per year.

The default estimates of the expected annual number of floods at each depth are shown in scientific notation because these numbers may vary over an extremely wide range, including very small numbers.

Except when annual probabilities approach one, the expected annual number of floods and the annual probability for each flood depth are virtually identical.

For a **Level One** analysis, these default estimates of the expected annual number of floods at the site under evaluation should be used.

> **HELPFUL HINT:**
>
> If flood discharge and flood elevation data are NOT available from a FIS or equivalent information, a Level Two Flood Hazard Risk assessment must be prepared.

User-Entered Flood Estimates

If desired, user-entered estimates of the annual probabilities of floods of each flood depth can be entered in the **LIGHT BLUE (Override Default)** column of the Flood Hazard Table. Making such estimates and other possible modifications of the default flood estimates are discussed below in the **Level Two Flood Analysis** section.

Level Two Flood Analysis

There are two ways to conduct a **Level Two** Flood Hazard Risk Analysis:

1. The flood data entry table (above) can be completed with estimates based on limited data or informed judgement. Such an analysis will be less accurate than analyses using FIS or FIRM (or equivalent) data, but flood estimates will be approximately correct as long as the input estimates are reasonable for the area under evaluation. Such an analysis is a **Level Two** analysis because it requires interpolation or extrapolation of limited data and/or other professional judgement about flood risks.
2. The default values of the **Expected Annual Number of Floods** for each flood depth can be overridden with user-entered estimates. This option requires an independent source of flood data, such as a US Army Corps of Engineers' floodplain study or other data from a professional

hydraulics engineer experienced in flood modeling. Such flood data **MUST** be expressed as **Expected Annual Number of Floods** at the appropriate location and elevation under evaluation. To override the default estimates in the **BROWN** column, user-entered values are entered in the **LIGHT BLUE** column. Whenever user estimates of the expected annual number of floods are entered, the program uses these values rather than the default values, although the default values are displayed for comparison to the user-entered values.

HELPFUL HINT:

A Level Two Analysis of Flood Hazard Risk requires a substantial amount of technical expertise and should not be prepared without properly qualified professional guidance.

Flood Hazard Risk: Technical Appendix

Flood Recurrence Intervals

Floods are a probabilistic natural phenomenon: it is impossible to predict in what years floods will occur or how severe the floods will be. Flood hazards are often expressed in terms of flood frequencies or recurrence intervals, such as a 10-year flood or a 100-year flood.

A "100-year" flood means that there is a 1% chance per year of a flood at the 100-year or higher flood elevation. A 10-year flood means that there is a 10% chance of a flood of the 10-year or higher flood elevation. In general, the annual probability of a flood of X-years is 1/X. Thus, the annual probability of an 83-year flood is 1/83 or 0.012.

Flood recurrence intervals do not mean that floods occur exactly at these intervals; rather they only express the probabilities of floods. Thus, a given location may experience two 100-year floods in a short time period or go several decades without experiencing a 10-year flood.

Flood recurrence intervals (in years) and annual flood probabilities contain exactly the same probabilistic information. The previous paragraphs explained how to convert recurrence intervals in years into annual probabilities. Conversely, annual probabilities can be converted to recurrence intervals. The recurrence interval in years of a flood depth with Y annual probability is 1/Y. For example, the recurrence interval for a flood with an annual probability of 0.01234 is 1/0.01234 or 81 years.

In the **Benefit-Cost (BC) Program**, flood probabilities are expressed in

terms of annual probabilities. If desired, these probabilities can be converted to recurrence intervals by the procedure discussed above.

Flood Exceedance Probabilities

The **Expected Annual Number of Floods** for each flood depth corresponds closely to annual probabilities of floods. Such probabilities are **interval** probabilities; that is, they express the probabilities for each flood depth. For example, in the BC Program, the annual probability of a 2-foot flood is considered to be the annual probability for all floods between 1.5 and 2.5 feet of depth at that site.

Flood probabilities are often expressed as exceedance probabilities. An exceedance probability means the probability of all floods greater than or equal to some specified flood. Thus, the annual exceedance probability for a 2-foot flood means the annual probability for all floods greater than or equal to 2 feet.

To avoid confusion, the distinction between interval probabilities and exceedance probabilities must be clearly made. The commonly used term, "100-year flood," is actually an exceedance probability. In other words, the 100-year flood level with an annual probability of 0.01 means all floods greater than or equal to this level. The interval probability of a flood at exactly (within plus or minus 0.5 feet) the 100-year flood level will be smaller (sometimes much smaller) than the exceedance probability for a 100-year flood, because the exceedance probability includes **ALL** floods greater than or equal to the 100-year flood.

For completeness, the BC Program tabulates both exceedance and interval probabilities, although all calculations are done using the interval probabilities. Plots of flood probabilities (both exceedance and interval) may be viewed by clicking on the plot buttons at the end of the Flood Hazard Screen in the BC Program.

Expected Annual Number of Floods

The Riverine Flood module uses an approach outlined by the US Army Corps of Engineers for riverine flooding (Flood Proofing, How to Evaluate Your Options, 1993).

The **Expected Annual Number of Floods** at each flood depth are calculated from the flood frequency and flood elevation data entered by the user, along with the **First Floor Elevation (FFE)** of the building under evaluation.

FLOOD HAZARD DATA

Data from Flood Insurance Study (FIS)

Flood Frequency (years)	Discharge (cfs)	Elevation (ft)
10	279,000	5.3
50	361,000	7.4
100	377,000	8
500	444,000	9.5

The flood frequency data (i.e., 10-, 50-, 100-, or 500 years) correspond to exceedance probabilities (see **Flood Recurrence Intervals** section on page 70). The computer program does a regression analysis fit between the logarithm of exceedance probability and flood discharge to obtain a smooth curve relating exceedance probability and flood discharge.

Flood elevations are read by the program from the "discharge rating curve," which is the relationship between flood discharge and elevation. The regression analysis is done in this manner because the relationship between stream discharge and probabilities is smooth whereas the relationship between flood elevation and probabilities may be very irregular because of variations in stream valley shape.

This analysis gives the **Annual Exceedance Probability** for all floods, in one-foot increments of depth. From the **Annual Exceedance Probabilities**, calculated as described above, the **Expected Annual Number of Floods** in a given one-foot increment are calculated from the difference in exceedance probabilities of two flood depths. For example, the expected annual number for a 2-foot flood (i.e., all floods between 1.5 and 2.5 feet) at a given site (with a given **FFE**) is calculated as the exceedance probability for a 1.5-foot flood minus the exceedance probability for a 2.5-foot flood.

Flood Elevation vs. Flood Depth

For a given flood (e.g., a 100-year flood), the elevation of the flood water surface varies with location along the stream as shown by the **Flood Profile** (see page 67). Furthermore, at a given location along the stream the flood depth corresponding to a 100-year flood varies depending on the **FFE** of the building under evaluation.

In the BC Program, the **Expected Annual Number of Floods** is shown for each flood depth from -2 to +8 feet or greater **for the building under evaluation**. For a different building with a different **FFE**, the **Expected Annual Number of Floods** for each flood depth will be different. Thus, for example, the depth of a 100-year flood will differ for buildings at different **FFEs**.

C H A P T E R 8
BENEFIT-COST (BC) PROGRAM: Level Two ANALYSIS

Introduction

Chapter 6, Benefit-Cost (BC) Program: Level One Analysis, reviewed the data entries necessary to conduct a **Level One (Minimum Data) Benefit-Cost Analysis (BCA)**, relying heavily on default values built into the program. This chapter provides guidance for a **Level Two (Detailed) BCA** which may incorporate additional building-specific data.

ALL of the data input for a **Level Two (Detailed)** analysis involves making building-specific estimates which override the default values used in a **Level One (Minimum Data)** analysis.

For a **Level Two (Detailed)** analysis, there are five data tables where default information may be overridden by the user with building-specific information:

1. Building Depth-Damage Function
2. Contents Depth-Damage Function
3. Displacement Time
4. Functional Downtime
5. Mitigation Project Effectiveness

This chapter reviews these five data tables and provides guidance about making building-specific estimates.

LEVEL TWO DATA: BUILDING DEPTH-DAMAGE FUNCTION

The **Building Depth-Damage Function (DDF)** indicates a building's vulnerability to flood damage by showing the expected levels of damage, both as a percentage of building replacement value and as dollars of damage for each flood depth. The **Building DDF** is the damage estimated

to occur to a building at each flood depth.

The **Building DDF** section of the **Level Two** (Detailed) BCA is reached via the Benefit-Cost (BC) Program menu tree: **Level Two Data | Building Depth-Damage** Functions

The BC Program contains two types of Building DDF tables: BEFORE and AFTER mitigation. These determine the effect of the proposed mitigation project by evaluating the Building DDFs before and after the project is in-place.

Reference Information from Level One Data

Carry Over Information

REFERENCE INFORMATION FROM LEVEL ONE DATA	
Building Type:	2 Story w/o Basement
Number of Stories Above Grade	2
Construction Date	1965
Historic Building Controls	No
Total Floor Area (square feet):	2,000
Total Building Replacement Value:	$150,000
Demolition Threshold Damage Percentage:	50.00%

PURPLE Blocks (Carry Over). Information from the **Level One Data** page is displayed to identify the building under consideration and to provide reference information and guidance for the **Level Two (Detailed)** analysis.

Building Depth-Damage Function (DDF) – Before and After Mitigation

Building Depth-Damage Table

Flood Depth (feet)	ESTIMATED BUILDING DAMAGE			
	Default DDF (%)	User-Entered DDF (%)	Modified DDF (%)	Modified DDF ($)
-2	0		0	$0
-1	0		0	$0
0	5		5	$7,500
1	9		9	$13,500
2	13		13	$19,500
3	18		18	$27,000
4	20		20	$30,000
5	22		22	$33,000
6	24		24	$36,000
7	26		26	$39,000
8	29		29	$43,500
>8	33		33	$49,500

There are five columns in the **Building Depth-Damage Table**. The first column shows the range of **Flood Depths** considered, from -2 to +8 feet or greater. The next three columns contain damage estimates in percentages of the building replacement value: **Default DDF (%)**, **User-Entered DDF (%)**, and **Modified DDF (%)** (to account for the demolition damage threshold percentage). The fifth column converts the **Modified DDF ($)** from percentages of damage into dollars of damage.

Building DDF (%)

BROWN Blocks (Default). The **Default Building DDF** estimates shown are based on the building type selected during the Level One data entry and the Federal Insurance Administration (FIA) data. FIA data on hundreds of thousands of flood damage claims are categorized into six classes of structures (see Building Type in Chapter 4). These FIA data are predominantly, but not entirely, for residential buildings.

In conformance with the FIA depth-damage data, the depth-damage table runs from -2 to +8 feet or greater, with all depths relative to the **First Floor Elevation (FFE)** of the building (i.e., the top of the first finished floor). Damage data is included for depths below 0 feet because damage occurs at these flood levels for buildings with basements.

The default depth-damage estimates have several limitations:

1. Only six (6) classes of buildings are included.
2. No distinction is made between different types of construction. For example, one-story wood frame and masonry buildings are grouped in

the same class.

3. No distinction is made for differences in construction practices or age of structures.
4. FIA depth-damage estimates encompass all claims, including flood damage due to high velocity flows, ice, or debris flows, or erosion and soil/foundation failures. However, the preponderance of claims is due to water depth only and thus these depth-damage estimates approximate water depth only damages.
5. Damage estimates do not consider the flood duration.
6. Depth-damage data at high flood depths are based on many fewer claims than at lower flood depths and thus may be less reliable.

For the above reasons, the **Default DDF** data should be regarded as a useful approximation to actual expected water depth-damages, but certainly not as absolute truth for all circumstances.

FIA Depth-Damage Table

The **FIA Depth-Damage Data** table on the next page displays the default depth-damage estimates by flood depth for the six classes of building types plus the "other" classification included in the BC Program. These estimates are from FIA flood damage claim data; values at a few depths have been interpolated between FIA data points.

FIA DEPTH-DAMAGE DATA							
Building Type	**1 Story, without Basement**	**2 Story, without Basement**	**Split Level without Basement**	**or 2 Story, with Basement**	**Split Level, with Basement**	**Mobile Home**	**Other**
Flood Depth (ft)	**Percent Damaged (% of Building Value)**						
-2	0	0	0	4	3	0	0
-1	0	0	0	8	5	0	0
0	9	5	3	11	6	8	0
1	14	9	9	15	16	44	0
2	22	13	13	20	19	63	0
3	27	18	25	2	22	7	0
4	29	20	27	28	27	78	0
5	30	22	28	33	32	80	0
6	40	24	33	38	35	81	0
7	43	26	34	44	36	82	0
8	44	29	41	49	44	82	0
>8	45	33	43	51	48	82	0

User-Entered DDF (%)

LIGHT BLUE Blocks (Override Default). If the **Default DDF** does not accurately reflect the specific building under evaluation, an analyst may enter more appropriate estimates based on engineering judgement and common sense. If the **OTHER** building type is selected, then no default values are provided and the user **MUST** enter building-specific estimates. Whenever a user enters a depth-damage estimate, the program uses these values rather than the default values, although the default values are displayed for comparison to the user-entered values.

If building damage data at one observed flood depth are available, this value may be used to calibrate the user-entered building DDF. The percent damage at this flood depth can be set to agree with the actual damages, and damages at other flood depths can be smoothly adjusted to be consistent with the observed damage data point. However, it is important to note that the damages in a single flood may or may not be representative of future expected damages, depending on whether or not unusual circumstances affected the observed damages.

Overriding the default depth-damage estimates is perfectly acceptable, indeed it is required, in order to get a valid BCA whenever the default estimates do not accurately reflect the building under evaluation. For example, if a building is unusually resistant or unusually vulnerable to flood damage this information should be reflected in the user-entered depth-damage function.

Also, the default depth-damage estimates consider predominantly water depth. If high velocity flows, ice, or debris-induced damage, erosion and soil/foundation failure, or unusually long-duration flooding are likely, then default depth-damage estimates **MUST** be adjusted accordingly.

HELPFUL HINT:

A user-entered Building DDF MUST be entered whenever high velocity flows, ice or debris-induced damage, erosion and soil/foundation failure, or unusually long-duration flooding are likely.

Modified DDF (%)

YELLOW Blocks (Results). The **Modified DDF (%)** takes into account the demolition threshold damage percentage entered on the **Level One Data** page and adjusts the DDF accordingly. For example, if the demolition percentage is 40% then all damages at or above 40% are assumed to be 100%, because the building would be expected to be demolished as a total loss at that level of damage.

YELLOW Blocks (Results). The depth-damage percentages of the **Modified DDF (%)** are converted to dollars in the final column of the depth-damage table.

YELLOW Blocks (Results). The depth-damage percentages of the **Modified DDF (%)** are converted to dollars in the final column of the depth-damage table.

Building DDF - AFTER Mitigation

The Building DDF - AFTER Mitigation table contains the same five columns as the BEFORE - Mitigation table, but also includes a column titled “EFFECTIVE %” which provides the level of protection for each flood depth.

The **BEFORE** and **AFTER** tables are shown on the same BC Program screen.

Data Sources and Documentation

Data Sources And Documentation

PINK Block (Information Only). This comment box may be used to record specific information about the building under evaluation. This includes information which affects its vulnerability to flood damage or any other information or assumptions that affect the user-entered depth-damage estimates (such as floods with debris or long duration flooding). Additionally, if **OTHER** was selected as the building type, a description of the building and its estimated depth-damage function should be entered here.

NEXT SCREEN

Click on the **NEXT SCREEN** button to proceed to the Contents DDF data entry screen.

LEVEL TWO DATA: CONTENTS DEPTH-DAMAGE FUNCTION

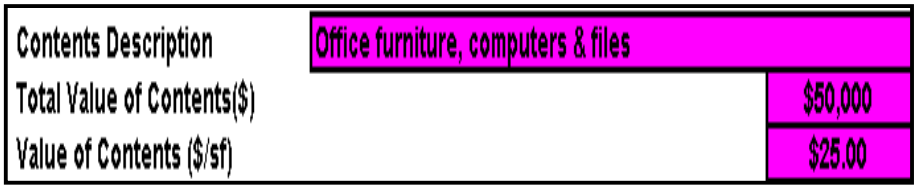
The **Contents Depth-Damage Function (DDF)** indicates the building contents' vulnerability to flood damage by showing the expected levels of damage, both as a percentage of contents value and as dollars of damage for each flood depth.

The BC Program contains two types of Contents DDF tables: **BEFORE** and **AFTER** Mitigation. These determine the effect of the proposed mitigation project by evaluating the Contents DDFs before and after the project is in-place.

The **Contents DDF** section of the **Level Two (Detailed)** BCA is reached via the **NEXT SCREEN** button at the bottom of the **Building DDF** screen or the menu tree: **Level Two Data | Contents Depth-Damage Function**

Reference Information from Level One Data

Carry Over Information



PURPLE Blocks (Carry Over). Information from the **Level One Data** page is displayed to identify the building under consideration and to provide reference information and guidance for the **Level Two (Detailed)** analysis.

Contents Depth-Damage Function (DDF)

Contents Depth-Damage Function (DDF)

Flood Depth (feet)	Building DDF(%)	ESTIMATED CONTENTS DAMAGE - BEFORE		
		Default DDF (%)	User-Entered DDF (%)	Contents DDF ($)
-2	0	0.0		$0
-1	0	0.0		$0
0	5	7.5		$3,750
1	9	13.5		$6,750
2	13	19.5		$9,750
3	18	27.0		$13,500
4	20	30.0		$15,000
5	22	33.0		$16,500
6	24	36.0		$18,000
7	26	39.0		$19,500
8	29	43.5		$21,750
>8	33	49.5		$24,750

There are five columns in the **Contents Depth-Damage Table**. The first column shows the range of **Flood Depths** considered, from -2 to +8 feet or greater. The second column carries over the Building DDF (%). The third and fourth columns provide the **Default DDF (%)** and the optional User-Entered DDF (%) for **ESTIMATED CONTENTS DAMAGE - BEFORE** Mitigation. The fifth column, **DDF ($)**, converts the **Default DDF (%)** or, if entered, the **User-Entered DDF (%)** values into dollars.

Contents DDF (%)

BROWN Blocks (Default). The **Default Contents DDF** values shown are 150% of the default building damage percentages for the building type selected. The 150% multiplier assumes that typical contents are more vulnerable to flood damage than are typical buildings.

The **Default Contents DDF** depends **ONLY** on the building type selected, **NOT** on the contents in any particular building. The vulnerability of contents to flood damage may vary markedly depending on the type of contents. For example, rare books are much more vulnerable than are used bricks. Therefore, users should enter building-specific estimates of the contents **DDF** whenever possible.

User-Entered DDF (%)

LIGHT BLUE Blocks (Override Default). If the **Default DDF** does not accurately reflect the **Contents DDF** of the specific building under evaluation, the user may enter more appropriate estimates based on engineering judgement, actual contents, and common sense. Also, if the **OTHER** building type is selected, then no default values are provided and the user **MUST** enter building-specific **Contents DDF** estimates. Whenever a user enters a depth-damage estimate, the program uses these values rather than the default values, although the default values are displayed for comparison to the user-entered values.

If contents damage data at one observed flood depth are available, then this value may be used to calibrate the user-entered **Contents DDF**. In this case, the percent damage at the observed flood depth can be set to agree with the observed damages, and damages at other flood depths can be smoothly adjusted to be consistent with the observed damage data point. However, it is important to note that the damages in a single flood may or may not be representative of future expected damages, depending on whether or not unusual circumstances affected the observed damages.

Overriding the default depth-damage estimates is perfectly acceptable, indeed it is required to get a valid Benefit-Cost Analysis (BCA) whenever the default estimates do not accurately reflect the building under evaluation. For example, if building contents are unusually resistant or unusually vulnerable to flood damage, this information should be reflected in the user-entered **Contents DDF**.

Also, the default depth-damage estimates consider predominantly water depth. If high velocity flows, ice, or debris-induced damage, erosion and soil/foundation failure, or unusually long-duration flooding are likely, then the default depth-damage estimates **MUST** be adjusted accordingly.

HELPFUL HINT:

A user-entered Contents DDF MUST be entered whenever high velocity flows, ice or debris-induced damage, erosion and soil/foundation failure, or unusually long-duration flooding are likely.

Contents DDF ($)

YELLOW Blocks (Results). The contents depth-damage percentage estimates are converted to dollars in the final column of the **Contents Depth-Damage Table**.

Contents DDF-After Mitigation

The Contents DDF - AFTER Mitigation table contains the same five columns as the BEFORE - Mitigation table, but also includes a column titled "EFFECTIVE %" which provides the level of protection for each flood depth.

The **BEFORE** and **AFTER** tables are shown on the same Benefit-Cost (BC) Program screen.

Data Sources and Documentation

Data Sources and Documentation

PINK Block (Information Only). This comment box may be used to record specific information about the building under evaluation. This includes information which affects its vulnerability to flood damage or any other information or assumptions that affect the user-entered depth-damage estimates (such as floods with debris or long duration flooding).

Additionally, if **OTHER** was selected as the building type, a description of the building contents and their estimated depth-damage function should be entered here. As with the **Building DDF**, if **OTHER** is selected, no default values for the **Contents DDF** are provided.

NEXT SCREEN

Click on the NEXT SCREEN button to proceed to the DISPLACEMENT TIME data entry screen.

LEVEL TWO DATA: DISPLACEMENT TIME

The **Displacement Time Estimates** indicate the occupants' vulnerability to flood damage by showing the expected levels of displacement time, displacement costs, and rental income losses for each flood depth. **Displacement Time** is the number of days occupants must vacate the building because of flood damage. **Displacement Time** may be shorter than the repair time, because some flood damage repairs can be made with occupants in the building.

Reference Information from Level One Data

Carry Over Information

Rental Cost of Temporary Building Space ($/sf/month)	$1.50
Rental Cost of Temporary Building Space ($/month)	$2,250
Other Costs of Displacement ($/month)	$500
Total Displacement Costs ($/month)	$2,750
One-Time Displacement Costs($)	$1,500
Total Monthly Rent from All Tenants ($/month)	$500

PURPLE Blocks (Carry Over). Information from the **Level One Data** page is displayed to identify the building under consideration and to provide reference information and guidance for the **Level Two (Detailed)** evaluation.

Displacement Time Due to Building Flood Damage

Displacement Time Due to Building Flood Damage Tables

There are six columns in the **Displacement Time Due to Building Flood Damage Table**. The first column shows the range of flood depths considered, from -2 to +8 feet or greater. The second column carries forward the **Modified DDF (%)** from the **Building Depth-Damage Table** for guidance. The third column, **Default** (days), shows the estimated number of days of displacement by flood depth. The fourth column, **User-Entered** (days**)**, is for the user to override the default estimates by entering building-specific estimates. The fifth column calculates the **Displacement Costs** by flood depth from the **Default** or, if entered, the **User-Entered Displacement Time Estimates** (days) and the **Total Displacement Costs** ($/day). The sixth column calculates the **Rental Income Losses** by flood depth from the **Default** or **User-Entered Displacement Time Estimates** and the **Total Monthly Rent From All Tenants**.

DISPLACEMENT TIME DUE TO BUILDING FLOOD DAMAGE					
BEFORE MITIGATION					
Flood Depth (feet)	Modified DDF (%)	Default (days)	User-Entered (days)	Displacement Costs	Rental Income Losses
-2	0	0		$0	$0
-1	0	0		$0	$0
0	5	0		$0	$0
1	9	0		$0	$0
2	13	54		$6,450	$900
3	18	94		$10,117	$1,567
4	20	110		$11,583	$1,833
5	22	126		$13,050	$2,100
6	24	142		$14,517	$2,367
7	26	158		$15,983	$2,633
8	29	182		$18,183	$3,033
>8	33	214		$21,117	$3,567

Default Displacement Time (days)

BROWN Blocks (Default). The **Default Displacement Time Estimates** (days) are derived from the **Modified DDF (%)** shown in the **Building Depth-Damage Table**. The **Default** estimates assume that no displacement (i.e., renting of temporary space) occurs if the building sustains less than 10% damage. However, if the estimated building damage is greater than 10%, then the **Default** estimates of **Displacement Time** are scaled between 30 and 365 days. The 30 day minimum assumes that occupants won't relocate to temporary space if the damage is repairable within 30 days. The 365 day maximum assumes that all repairs will be completed and occupants will be back in the original space within one year.

User-Entered Displacement Time (days)

LIGHT BLUE Blocks (Override Default). If the **Default Displacement Time Estimates** do not accurately reflect the displacement times estimated for the occupants of the specific building under evaluation, analysts may enter more appropriate estimates based on engineering judgement, actual days of displacement observed, and common sense. Whenever an analyst enters a **Displacement Time Estimate**, the program uses these values rather than the default values, although the default values are displayed for comparison to the user-entered values.

If data for actual **Displacement Time** at one observed flood depth are available, then this information may be used to calibrate the user-entered **Displacement Time Estimate**. In this case, the **Displacement Time** at the observed flood depth can be set to agree with the observed displacement time; estimated displacement times at other flood depths can be smoothly adjusted to be consistent with the observed **Displacement Time** data point. However, it is important to note that the **Displacement Time** in a single flood may or may not be representative of future expected times, depending on whether or not unusual circumstances affected the observed time.

Overriding the **Default Displacement Time Estimates** is perfectly acceptable, indeed it is required to get a valid BCA whenever the default

estimates do not accurately reflect the building under evaluation. For example, if local conditions suggest that unusually long or short displacement times are likely, this should be reflected in the **User-Entered Displacement Time Estimates**.

Displacement Costs

YELLOW Blocks (Results). The **Default Displacement Time Estimates,** or**,** if entered, the **User-Entered Displacement Time Estimates** are converted into **Displacement Costs** based on the **Total Cost of Displacement** per day (from the **Level One Data** page) and the estimated days of displacement for each flood depth.

Rental Income Losses

YELLOW Blocks (Results). The **Default Displacement Time Estimates,** or**,** if entered, the **User-Entered Displacement Time Estimates** are converted into **Rental Income Losses** based on the **Total Monthly Rent from All Tenants** ($/month, from the **Level One Data** page) and the estimated days of displacement for each flood depth.

Displacement Time - AFTER Mitigation

The Displacement Time - AFTER Mitigation table contains the same six columns as the BEFORE-Mitigation table and provides data with the project in-place.

The **BEFORE** and **AFTER** tables are shown on the same BC Program screen.

Data Sources and Documentation

Data Sources And Documentation

PINK Block (Information Only). This comment box should be used to record specific information about the **Displacement Time Estimates** and how they are governed by the building's vulnerability to flood damage and any other information, assumptions or local conditions which affect the user-entered **Displacement Time Estimates**.

Next Screen

Click on the NEXT SCREEN button to proceed to the FUNCTIONAL DOWNTIME data entry screen.

LEVEL TWO DATA: FUNCTIONAL DOWNTIME

Functional Downtime is the number of days a public/nonprofit agency cannot provide services due to disaster-caused damage. For example, an agency may have to relocate out of its building for 60 days, but may resume service provision from temporary quarters after only 7 days. Thus, in this case, the functional downtime due to disaster damage is 7 days. **Functional Downtime** is also used to estimate business income losses (if applicable)

due to flood damage.

Reference Information from Level One Data

Carry Over Information

Cost of Providing Services from this Building ($/day)	$563
Post-Disaster Continuity Premium ($/day)	$500
Total Value of Lost Services ($/day)	$1,063
Estimated Net Income of Commercial Businesses ($/month)	$1,500

PURPLE Blocks (Carry Over). Information from the **Level One Data** page is displayed to identify the building under consideration and to provide reference information and guidance for the **Level Two (Detailed)** evaluation.

Functional Downtime Estimates

Functional Downtime Table

Flood Depth (feet)	Building DDF (%)	Default Downtime (days)	User-Entered Downtime (days)	Value of Lost Services	Lost Business Income
-2	0	0		$0	$0
-1	0	0		$0	$0
0	5	5		$5,315	$250
1	9	9		$9,567	$450
2	13	13		$13,819	$650
3	18	18		$19,134	$900
4	20	20		$21,260	$1,000
5	22	22		$23,386	$1,100
6	24	24		$25,512	$1,200
7	26	26		$27,638	$1,300
8	29	29		$30,827	$1,450
>8	33	30		$31,890	$1,500

There are six columns in the **Functional Downtime Estimates** table.

The first column shows the range of flood depths considered, from -2 to +8 feet or greater.

The second column carries forward the **Building DDF** (%) from the **Building Depth-Damage** table for guidance.

The third column, **Default Downtime (days)**, shows the estimated number of days of loss of function by flood depth.

The fourth column, **User-Entered Downtime (days)**, is for the user to override the default estimates by entering building-specific estimates.

The fifth column calculates the **Value of Lost Services** by flood depth from the **Default** or, if entered, the **User-Entered Functional Downtime Estimates** (days) and the **Total Value of Lost Services** ($/day).

The sixth column calculates the **Lost Business Income** by flood depth from the **Default** or **User-Entered Functional Downtime Estimates** and the **Estimated Net Income of Commercial Businesses** ($/month).

Default Functional Downtime (days)

BROWN Blocks (Default). The **Default Downtime Estimates** (days) are derived from the **Building DDF (%)** carried over from the **Building Depth-Damage Function Table**. The **Default Downtime Estimates** assume that if the building sustains less than 10% damage, then one day of **Functional Downtime** occurs for each 1% of damage. However, if the estimated building damage is greater than 10%, then the **Default Downtime Estimates** are scaled between 10 and 30 days.

It is assumed that public/nonprofit agencies and businesses will resume function in temporary quarters, if necessary, within 30 days; thus the **Default Functional Downtime Estimates** are capped at 30 days.

User-Entered Functional Downtime (days)

LIGHT BLUE Blocks (Override Default). If the **Default Functional Downtime Estimates** do not accurately reflect the **Functional Downtime** estimated for the specific building under evaluation, users may enter more appropriate estimates based on engineering judgement, actual days of downtime experienced, and common sense. Whenever an analyst enters a **Functional Downtime Estimate**, the program uses these values rather than the default values, although the default values are displayed for comparison to the user-entered values.

If data on actual **Functional Downtime** at one observed flood depth are available, then this information may be used to calibrate the user-entered **Functional Downtime Estimate**. In this case, the **Functional Downtime** at the observed flood depth can be set to agree with the observed time and estimated times at other flood depths can be smoothly adjusted to be consistent with the observed **Functional Downtime** data point. However, it is important to note that the **Downtime** in a single flood may or may not be representative of future expected **Downtimes**, depending on whether or not unusual circumstances affected the observed **Functional Downtime**.

Value of Lost Services

YELLOW Blocks (Results). The Value of Lost Services for each flood depth is based on the product of the Estimated Value of **Public/Nonprofit Services Provided ($/day)** from the **Level One Data** page and the estimated days of **Functional Downtime (days)** for each flood depth.

Lost Business Income

YELLOW Blocks (Results). Similarly, the **Lost Business Income** for each flood depth is based on the product of the **Estimated Net Income of Commercial Businesses ($/month)** from the **Level One Data** page and the estimated days of **Functional Downtime** for each flood depth.

Functional Downtime – AFTER Mitigation

The Functional Downtime - AFTER Mitigation table contains the same six columns as the **BEFORE-Mitigation** table and provides data with the project in-place.

The **BEFORE and AFTER** tables are shown on the same BC Program screen.

Data Sources and Documentation

Data Sources and Documentation

PINK Blocks (Information Only). This comment box should be used to record specific information about the occupants' **Functional Downtime** as it is governed by the building's vulnerability to flood damage or any other information, local conditions, or assumptions which affect the user-entered **Functional Downtime Estimates**.

NEXT SCREEN

Click on the NEXT SCREEN button to proceed to the SUMMARY OF DAMAGES BEFORE MITIGATION data entry screen.

C H A P T E R 9
BENEFIT-COST (BC) PROGRAM: RESULTS

Introduction

This chapter summarizes all of the Benefit-Cost Analysis (BCA) results which are calculated from the data inputs. There are four main types of results:

1. Scenario Damages Before Mitigation.
2. Scenario of Damages After Mitigation.
3. Benefit-Cost Results.
4. Summary.

HELPFUL HINT:

ALL of the results depend directly on the input data for either a Level One (Minimum Data) or a Level Two (Detailed) analysis.

Results should always be reviewed for reasonableness. If any of the results appear unreasonable, then check the corresponding input parameters which lead to the results.

Each analyst conducting **BCA** has the responsibility to ensure that all data inputs are reasonable, defensible, and well-documented. The program processes all of the data inputs in a mathematically correct manner, but **the program cannot produce correct results when incorrect data are entered**. The analyst has control over the data inputs and thus responsibility for the results.

SUMMARY OF DAMAGES BEFORE MITIGATION

This section of results characterizes the vulnerability of the **Existing** building to flood damages and losses **BEFORE** undertaking any mitigation measures. The estimated scenario damages and losses for the existing building at each flood depth depend directly on the depth-damage functions (DDFs) for building and contents, displacement, and functional downtimes, and all of the other input parameters. The expected annual damages and losses also depend very strongly on the degree of flood risk at the site under evaluation.

Scenario Damages Before Mitigation ($ per event)

Scenario Damages Before Mitigation ($ per event)

Scenario Damages are defined as damages and losses per flood event. Scenario damages indicate the estimated damages which would result from a single flood of a particular depth at the building under evaluation. For example, the scenario damages for a 3-foot flood are the expected damages and losses **each time** a 3-foot flood occurs at a particular site. Scenario damages do **NOT** depend on the probability of floods at that location.

Scenario Damages Table

SCENARIO DAMAGES BEFORE MITIGATION ($ per event) — GRAPH

Flood Depth	Building Damages	Contents Damages	Displacement Costs	Business Losses	Rental Losses	Public/ Nonprofit	Total
-2	$0	$0	$0	$0	$0	$0	$0
-1	$0	$0	$0	$0	$0	$0	$0
0	$7,500	$3,750	$0	$250	$0	$5,315	$16,815
1	$13,500	$6,750	$0	$450	$0	$9,567	$30,267
2	$19,500	$9,750	$6,450	$650	$900	$13,819	$51,069
3	$27,000	$13,500	$10,117	$900	$1,567	$19,134	$72,218
4	$30,000	$15,000	$11,583	$1,000	$1,833	$21,260	$80,677
5	$33,000	$16,500	$13,050	$1,100	$2,100	$23,386	$89,136
6	$36,000	$18,000	$14,517	$1,200	$2,367	$25,512	$97,596
7	$39,000	$19,500	$15,983	$1,300	$2,633	$27,638	$106,055
8	$43,500	$21,750	$18,183	$1,450	$3,033	$30,827	$118,744
>8	$49,500	$24,750	$21,117	$1,500	$3,567	$31,890	$132,324

The **Scenario Damages Table** contains scenario damages for each flood depth from -2 to +8 feet or greater for seven categories of damages and losses: Building Damages, Contents Damages, Displacement Costs, Business Income Losses, Rental Income Losses, Public/Nonprofit Services

and Total Damages per Flood Depth. In addition, the total damages and losses are shown for each flood depth.

The information in this **Scenario Damages Before Mitigation Table** shows the total vulnerability of the existing building to flood damage, how these damages are distributed among different categories of damages, and how these damages vary with flood depth.

Expected Annual Damages Before Mitigation ($ per year)

The **Scenario Damages** discussed above do **NOT** depend on flood hazard risk. Two identical buildings located at different elevations in a floodplain will have identical scenario damages at each flood depth. However, the probability of flood damage varies markedly with elevation in a floodplain.

Expected Annual Damages take into account the annual probabilities of floods of each depth. These damages are the **AVERAGE** damages per year expected over a long time period. "Expected annual" does **NOT** mean that these damages will occur every year.

For each flood depth, **Expected Annual Damages** are calculated by multiplying the **Scenario Damages** times the **Expected Annual Number of Floods** of each depth.

EXPECTED ANNUAL DAMAGES BEFORE MITIGATION ($ per year) — GRAPH

Flood Depth	Building Damages	Contents Damages	Displacement Costs	Business Losses	Rental Losses	Public/ Nonprofit	Total
-2	$0	$0	$0	$0	$0	$0	$0
-1	$0	$0	$0	$0	$0	$0	$0
0	$369	$185	$0	$12	$0	$262	$828
1	$280	$140	$0	$9	$0	$198	$627
2	$239	$119	$79	$8	$11	$169	$625
3	$100	$50	$37	$3	$6	$71	$267
4	$37	$18	$14	$1	$2	$26	$99
5	$15	$7	$6	$0	$1	$11	$40
6	$6	$3	$3	$0	$0	$5	$18
7	$3	$2	$1	$0	$0	$2	$8
8	$2	$1	$1	$0	$0	$1	$4
>8	$2	$1	$1	$0	$0	$1	$5
Total	$1,052	$526	$142	$35	$21	$745	$2,521

The **Expected Annual Damage Table** contains expected annual damages for each flood depth from -2 to +8 feet or greater for seven categories of damages and losses: Building Damages, Contents Damages, Displacement Costs, Business Income Losses, Rental Income Losses, Lost Public/Nonprofit Services and Total Damages Per Flood Depth. In addition, the total damages and losses are shown for each flood depth.

Expected Annual Damages will generally be much smaller than **Scenario Damages** because the expected annual number or annual probability of a flood of a given depth is usually much less than 1.0.

Interpreting Damages Before Mitigation

Scenario Damages and **Expected Annual Damages** provide different information. **Scenario Damages** describe how much flood damage there will be each time a given flood occurs. However, because Scenario Damages **DO NOT** consider flood probabilities, they do not provide sufficient information for decision making. **Scenario Damages** for a given flood depth may be high, but if the flood probability is very low, no mitigation action may be warranted. For example, if a 5-foot flood causes $50,000 damages but such a flood is expected to occur only once in 1,000 years, then simply repairing the very infrequent flood damage may be the most sensible and cost-effective strategy.

The **Scenario Damages Before Mitigation** and the **Expected Annual Damages Before Mitigation** provide, **in combination**, a complete picture of the vulnerability of the building to flood damage before undertaking a mitigation project.

Expected Annual Damages DO consider flood probabilities. A building with high **Expected Annual Damages** means that not only are **Scenario Damages** high, but also that flood probabilities at the depths that cause considerable damages are relatively high. High **Expected Annual Damages** means that there are high **potential benefits** in avoiding such damages through mitigation projects.

Even for buildings with high **Expected Annual Damages**, all mitigation projects are not necessarily cost-effective. Cost-effectiveness depends on the cost and the effectiveness of the mitigation project in avoiding damages, as well as on the **Expected Annual Damages**.

Next Screen

Click on the NEXT SCREEN button to proceed to the SUMMARY OF DAMAGES AFTER MITIGATION data entry screen.

SUMMARY OF DAMAGES AFTER MITIGATION

This section of results characterizes the vulnerability of the building to flood damages and losses **AFTER** undertaking a particular mitigation measure. Scenario damages after mitigation depend on the damages before mitigation and on the effectiveness of the mitigation measure in avoiding damages. The **Expected Annual Damages and Losses** after mitigation also depend very strongly on the degree of flood and flood-related risks at the site under evaluation.

SCENARIO DAMAGES AFTER MITIGATION ($ per event)

Scenario Damages After Mitigation ($ per event)

Scenario Damages After Mitigation are the damages and losses expected to occur per flood event after the mitigation project is implemented. For some mitigation projects such as relocation or buyout, the **Scenario Damages After Mitigation** will be zero. For other projects, such as elevation or flood barriers, **Scenario Damages After Mitigation** will be lower than before mitigation but not zero at those flood depths where the mitigation measure is partially effective.

Scenario Damages After Mitigation indicate the estimated damages which would result from a single flood of a particular depth at the building under evaluation after completion of the mitigation project. For example, the scenario damages for a 3-foot flood are the expected damages and losses **each time** a 3-foot flood occurs at a particular site. Scenario damages **DO NOT** depend on the probability of floods at that location.

Scenario Damages Table

SCENARIO DAMAGES BEFORE MITIGATION ($ per event) — GRAPH

Flood Depth	Building Damages	Contents Damages	Displacement Costs	Business Losses	Rental Losses	Public/ Nonprofit	Total
-2	$0	$0	$0	$0	$0	$0	$0
-1	$0	$0	$0	$0	$0	$0	$0
0	$7,500	$3,750	$0	$250	$0	$5,315	$16,815
1	$13,500	$6,750	$0	$450	$0	$9,567	$30,267
2	$19,500	$9,750	$6,450	$650	$900	$13,819	$51,069
3	$27,000	$13,500	$10,117	$900	$1,567	$19,134	$72,218
4	$30,000	$15,000	$11,583	$1,000	$1,833	$21,260	$80,677
5	$33,000	$16,500	$13,050	$1,100	$2,100	$23,386	$89,136
6	$36,000	$18,000	$14,517	$1,200	$2,367	$25,512	$97,596
7	$39,000	$19,500	$15,983	$1,300	$2,633	$27,638	$106,055
8	$43,500	$21,750	$18,183	$1,450	$3,033	$30,827	$118,744
>8	$49,500	$24,750	$21,117	$1,500	$3,567	$31,890	$132,324

The **Scenario Damages After Mitigation Table** contains scenario damages for each flood depth from -2 to +8 feet or greater for seven categories of **avoided** damages and losses: Building Damages, Contents Damages, Displacement Costs, Business Income Losses, Rental Income Losses, Lost Public/Nonprofit Services and Total Losses Per Flood Depth. In addition, the total damages and losses are shown for each flood depth.

The information in this **Scenario Damages After Mitigation** table shows the total vulnerability of the building after mitigation to flood damage, how these damages are distributed among different categories of damages, and how these damages vary with flood depth. In the example table above,

Scenario Damages After Mitigation are zero for flood depths through 4 feet, because the mitigation measure (elevation) is 100% effective in avoiding damages at these flood depths.

Expected Annual Damages After Mitigation ($ per year))

Expected Annual Damages After Mitigation take into account the annual probabilities of floods of each depth. **Expected Annual Damages** are the **AVERAGE** damages per year expected over a long time period. "Expected annual" does not mean that these damages will occur every year.

Expected Annual Damages After Mitigation also take into account the effectiveness of the mitigation measure at each flood depth. For some mitigation projects such as relocation or buyout, the **Expected Annual Damages After Mitigation** will be zero. For other mitigation projects such as elevation or flood barriers, **Expected Annual Damages After Mitigation** will be lower than before mitigation but not zero.

For each flood depth, **Expected Annual Damages After Mitigation** are calculated by multiplying the **Scenario Damages** times the **Expected Annual Number of Floods** of each depth.

The **Expected Annual Damages After Mitigation** table (shown above) contains expected annual damages **AFTER** mitigation for each flood depth from -2 to +8 feet or greater for seven categories of **avoided** damages and losses: Building Damages, Contents Damages, Displacement Costs, Business Income Losses, Rental Income Losses, Lost Public/Nonprofit Services and Total Losses per Flood Depth. In addition, the total damages and losses **AFTER** mitigation are shown for each flood depth.

Interpreting Damages After Mitigation

The **Scenario Damages After Mitigation** and the **Expected Annual Damages After Mitigation** provide, in combination, a complete picture of the vulnerability of the building to flood damages after completing a mitigation project.

Next Screen

Click on the NEXT SCREEN button to proceed to the SUMMARY OF BENEFITS FROM MITIGATION data entry screen.

SUMMARY OF BENEFITS FROM MITIGATION

Benefits are damages and losses avoided because of the mitigation project. In other words, benefits are the difference in damages before and after the mitigation project. The **Expected Annual Benefits** of a mitigation project are the expected annual **AVOIDED** damages and losses. Thus, **Expected Annual Benefits** are the difference between **Expected Annual Damages Before Mitigation** and **Expected Annual Damages After Mitigation**.

Expected Annual Damages From Mitigation ($ per year))

Expected Annual Benefits From Mitigation ($ per year)

EXPECTED ANNUAL DAMAGES AFTER MITIGATION ($ per year) — GRAPH

Flood Depth	Building Damages	Contents Damages	Displacement Costs	Business Losses	Rental Losses	Public/ Nonprofit	Total
-2	$0	$0	$0	$0	$0	$0	$0
-1	$0	$0	$0	$0	$0	$0	$0
0	$0	$0	$0	$0	$0	$0	$0
1	$0	$0	$0	$0	$0	$0	$0
2	$0	$0	$0	$0	$0	$0	$0
3	$0	$0	$0	$0	$0	$0	$0
4	$0	$0	$0	$0	$0	$0	$0
5	$3	$2	$0	$0	$0	$2	$8
6	$2	$1	$0	$0	$0	$2	$5
7	$2	$1	$1	$0	$0	$1	$4
8	$1	$0	$0	$0	$0	$1	$3
>8	$1	$1	$0	$0	$0	$1	$3
Total	$9	$5	$1	$0	$0	$7	$23

This table shows the **Expected Annual Benefits** arising from the specific mitigation project under evaluation.

The **Expected Annual Benefits Table** (shown above) contains expected annual benefits for each flood depth from -2 to +8 feet and greater for seven categories of **avoided** damages and losses: Building Damages Avoided, Contents Damages Avoided, Displacement Costs Avoided, Business Income Losses Avoided, Rental Income Losses Avoided, Lost Public/Nonprofit Services Avoided, and Total Benefits per Flood Depth. In addition, the total damages and losses avoided after mitigation are shown for each flood depth. The **Total Expected Annual Benefits** due to the mitigation project are the sum of the **Total Avoided Damages and Losses** over all of the flood depths.

Next Screen

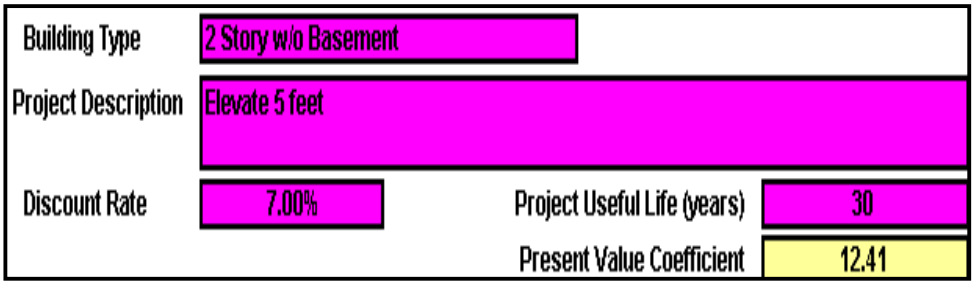
Click on the NEXT SCREEN button to proceed to the BENEFITS_COST RESULTS screen.

BENEFIT-COST RESULTS

This section of results has three subsections:

1. Reference Information From Level One Data.
2. Summary of Expected Damages and Benefits.
3. Summary of Project Benefits and Project Costs.

Reference Information From Level One Data



Discount Rate

The **Discount Rate** entry is determined by the Federal Office of Management and Budget (OMB) and FEMA policy and cannot be varied by the user on a project-by-project basis.

On October 29, 1992, OMB issued Circular A-94, Revised (Transmittal Memo No. 64), "Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs." In this Circular, OMB states that the appropriate discount rate varies depending on whether or not the investment (i.e., project) is an "internal Federal government investment."

For FEMA-funded hazard mitigation projects for state and local governments (or eligible nonprofit agencies), the OMB-mandated discount rate is the rate applicable for investments which are **not** internal Federal government investments. The OMB-mandated discount rate corresponds approximately to the 30-year Treasury bond rate, but the appropriate rate is specifically fixed by OMB annually. Currently, the OMB-mandated discount rate is 7% (see Appendix C of Circular A-94).

For each disaster, an appropriate discount rate should be determined by FEMA, in accordance with the OMB guidance, and applied **uniformly** to all hazard mitigation projects being considered. The discount rate determined for each disaster is entered in the **DARK BLUE** box under **Level One Data**. After this rate is determined and entered **once**, it can then be used for analysis of **ALL** hazard mitigation projects for this disaster.

HELPFUL HINT:

The discount rate is determined by OMB Guidance and is NOT a user-defined parameter.

A detailed review of the economic theory about discount rates is beyond the scope of this manual. However, the proper discount rate for Benefit-Cost Analyses (BCAs) is a "real" discount rate separate from any assumptions about inflation. For a detailed discussion, see: **A Benefit-Cost Model for the Seismic Rehabilitation of Federal Buildings**, Volume 2, Chapter 3, Discount Rates and Multipliers, FEMA, 1994.

Project Useful Life (years)

PURPLE Block (Carry Over). The **Project Useful Life**, entered on the **Level One (Minimum Data)** screen, is carried over for reference.

Present Value Coefficient

YELLOW Block (Result). The **Present Value Coefficient** is mathematically determined by the discount rate and the project useful lifetime. The **Present Value Coefficient** refers to the present value of $1.00 per year in benefits received over the project useful lifetime. In other words, the **Present Value Coefficient** is a multiplier of the expected annual benefits which determines the net present value of the expected annual benefits.

Calculated benefits and **Benefit-Cost Ratios (BCRs)** are directly proportional to the **Present Value Coefficient**. However, in every case the discount rate and project useful lifetime entered by an analyst **MUST** be commensurate with the actual funding source for the project (see **Discount Rate**, page 98) and the actual mitigation project (see **Project Useful Life**, page 61).

The following table shows the **Present Value Coefficient** for a wide range of discount rates and project useful lifetimes.

PRESENT VALUE COEFFICIENTS DISCOUNT RATES											
Years	**0%**	**1%**	**2%**	**3%**	**4%**	**5%**	**6%**	**7%**	**8%**	**9%**	**10%**
1	1.00	0.99	0.98	0.97	0.96	0.95	0.94	0.93	0.93	0.92	0.91
2	2.00	1.97	1.94	1.91	1.89	1.86	18.3	1.81	1.78	1.76	1.74
3	3.00	2.94	2.88	2.83	2.78	2.72	2.67	2.62	2.58	2.53	2.49
4	4.00	3.90	3.81	3.72	3.63	3.55	3.47	3.39	3.31	3.24	3.17
5	5.00	4.85	4.71	4.58	4.45	4.33	4.21	4.10	3.99	3.89	3.79
6	6.00	5.80	5.60	5.42	5.24	5.08	4.92	4.77	4.62	4.49	4.36
7	7.00	6.73	6.47	6.23	6.00	5.79	5.58	5.39	5.21	5.03	4.87
8	8.00	7.65	7.33	7.02	6.73	6.46	6.21	5.97	5.75	5.53	5.33
9	9.00	8.57	8.16	7.79	7.44	7.11	6.80	6.52	6.25	6.00	5.76
10	10.00	9.47	8.98	8.53	8.11	7.72	7.36	7.02	6.71	6.42	6.14
15	15.00	13.87	12.85	11.94	11.12	10.38	9.71	9.11	8.56	8.06	7.61
20	20.00	18.05	16.35	14.88	13.59	12.46	11.47	10.59	9.82	9.13	8.51
25	25.00	22.02	19.52	17.41	15.62	14.09	12.78	11.65	10.67	9.82	9.08
30	30.00	25.81	22.40	19.60	17.29	15.37	13.76	12.41	11.26	10.27	9.43
40	40.00	32.83	27.36	23.11	19.79	17.16	15.05	13.33	11.92	10.76	9.78
50	50.00	39.20	31.42	25.73	21.48	18.26	15.76	13.80	12.23	10.96	9.91
60	60.00	44.96	34.76	27.68	22.62	18.93	16.16	14.04	12.38	11.05	9.97
70	70.00	50.17	37.50	29.12	23.39	19.34	16.38	14.16	12.44	11.08	9.99
80	80.00	54.89	39.74	30.20	23.92	19.60	16.51	14.22	12.47	11.10	10.00
90	90.00	59.16	41.59	31.00	24.27	19.75	16.58	14.25	12.49	11.11	10.00
100	100.00	63.03	43.10	31.60	24.50	19.85	16.62	14.27	12.49	11.11	10.00
1000	1000.00	100.00	50.00	33.33	25.00	20.00	16.67	14.29	12.50	11.11	10.00

Summary of Expected Annual Damages and Benefits

Summary of Expected Damages and Benefits

SUMMARY OF EXPECTED DAMAGES AND BENEFITS

	Expected Annual Damages Before Mitigation	Expected Annual Damages After Mitigation	Expected Annual Benefits	Present Value of Annual Benefits
Building Damages	$1,052	$9	$1,042	$12,936
Contents Damages	$526	$5	$521	$6,468
Displacement Costs	$142	$1	$140	$1,741
Business Income Lost	$35	$0	$35	$431
Rental Income Lost	$21	$0	$21	$256
Public Services Lost	$745	$7	$739	$9,166
Total Losses & Benefits	$2,521	$23	$2,498	$30,999

YELLOW Blocks (Results). There are five columns in the **Summary of Damages and Losses** table. The first column contains the six types of damages and losses considered, along with a total. The second column is the **Expected Annual Damages Before Mitigation**. The third column is the **Expected Annual Damages After Mitigation**. The fourth column is the **Expected Annual Benefits**. The fifth column is the **Present Value of Annual Benefits**.

Expected Annual Damages Before Mitigation

The **Expected Annual Damages Before Mitigation** indicate the estimated average annual damages that are expected to occur before the mitigation project is completed. These figures indicate the vulnerability of the existing building to flood damages. See page 91 for more discussion.

Expected Annual Damages After Mitigation

The **Expected Annual Damages After Mitigation** are the expected annual residual damages after completion of the mitigation project. In some cases, these damages and losses will be zero (e.g., for buyout or relocation projects). See page 95 for more discussion.

Expected Annual Benefits

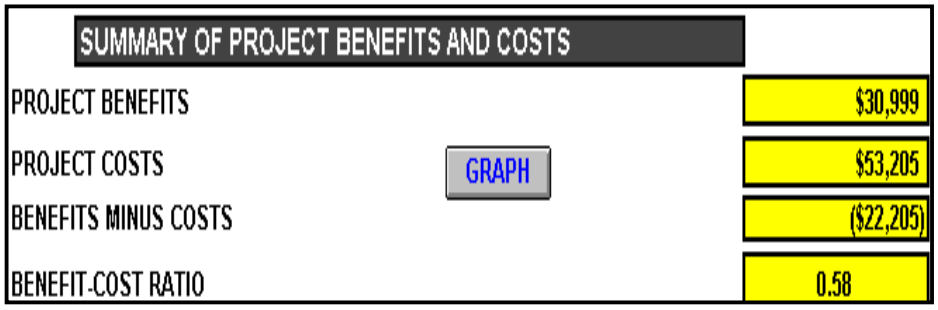
The **Expected Annual Benefits** of the mitigation project are the **Expected Annual Avoided Damages**. The **Benefits** of the mitigation project are exactly the amount of damages and losses that do not occur (i.e., are avoided) because of the mitigation measure. Thus, **Expected Annual Benefits** are the **difference** between **Expected Annual Damages Before Mitigation** and **Expected Annual Damages After Mitigation**. See page 93 for more discussion of the calculation of **Expected Annual Benefits**.

Present Value of Annual Benefits

The **Benefits** are the present value (over the lifetime of the mitigation project under evaluation) of the **Expected Annual Benefits** or the present value of damages avoided. The last column of the **Summary of Expected Annual Damages and Benefits Table** shows the **Benefits** (present value of damages avoided) for each of the six categories of damages and losses and in total.

Summary of Project Benefits and Costs

Project Benefits and Project Costs



Project Benefits

YELLOW Block (Result). The **Project Benefits**, which were calculated and displayed as the last entry in the bottom right corner of the **Summary of Expected Annual Damages and Benefits Table**, are presented again here. **Project Benefits** (i.e., the net present value of the **Expected Annual Benefits** over the lifetime of the project) are the product of the **Present Value Coefficient** and the **Expected Annual Benefits**.

Project Costs

YELLOW Block (Result). The **Project Costs** are carried over from the **Level One Data** entry page, where they were entered, for comparison to the calculated **Project Benefits**.

Benefits Minus Costs

YELLOW Block (Result). The difference between **Project Benefits** and **Project Costs** is displayed here in dollars. This value, also known as the present value criterion, shows the magnitude of the difference between **Benefits** and **Costs**. The present value criterion may be greater than 0.0 (if benefits exceed costs) or less than 0.0 (if costs exceed benefits).

Benefit-Cost Ratio (BCR)

YELLOW Block (Result). The BCR is the **Project Benefits** divided by the **Project Costs**. For hazard mitigation projects under either Section 404 or Section 406, the **BCR must be equal to or greater than 1.0** for funding eligibility.

Interpreting BC Results

BCRs, like all of results of BCAs, depend directly on the input data. Varying any of the input data which affect numerical results (i.e., changing any of the entries in **GREEN**, **LIGHT BLUE**, or **DARK BLUE Data Entry Blocks**) will change the BCR.

The sensitivity of calculated benefits and/or BCRs with respect to changes in the data inputs may be explored by varying individual input parameters (**within credible or justifiable limits**) and noting the impact on the resulting calculated benefits. Some of the input parameters have little impact on the BCR because they only govern a tiny portion of the benefits. Other input parameters have a major impact on Benefit-Cost (BC) results. The relative importance of each input parameter will vary from project to project depending on the specifics of each individual project.

Because of the inherent uncertainties, BC results, like any calculation, should not be interpreted blindly or in disregard of the uncertainties. For example, three prospective flood hazard mitigation projects with BCRs of 0.2, 1.2, and 2.2 are almost certainly distinguishable. Three prospective projects with BCRs of 0.95, 1.00, and 1.05 are probably not significantly different. Three projects with ratios of 0.8, 1.0, and 1.2 may or may not be significantly different, depending on the validity of the input data.

BCRs near 1.0 will always be in a gray area of interpretation. Depending on the accuracy of the input data, BCRs near 1.0 (e.g., 0.9 or 1.1) may not be significantly different than the project with a BCR of 1.0. That is, with reasonable and defensible variations in estimates made in the input parameters, the BCRs may be either somewhat above or somewhat below 1.0.

The real power of a BCA is to separate projects with BCRs substantially below 1.0 from projects with BCRs substantially above 1.0. There will always be projects on the borderline, subject to results indicating BCRs greater than or less than 1.0, depending on variations in input data assumptions.

In this context, the relative rankings of BC results may be more significant than the absolute BCRs. Thus, if similar assumptions are made about roughly similar projects, the ranking of BCRs accurately reflects relative differences between the projects, while the absolute numerical values of BCRs reflect the general assumptions made in conducting the analyses.

In comparing a range of projects with varying costs, benefits, and BCRs, it is essential to consider the scale of the projects as well as the simple BCR. For example, a $5,000 project with a BCR of 2.0 (i.e., benefits of $10,000, present value criterion of $5,000) is not intrinsically a "better" project than a $500,000 project with a BCR of 1.5 (i.e., benefits of $750,000 and a present value criterion of $250,000). Thus, in comparing projects it is necessary to consider both the BCRs and the present value criterion (or the

total amount of dollar benefits). Simple comparisons of projects using only the BCRs are valid if and only if the projects are of closely similar size (cost).

As discussed in **Chapter 5, BC Model: Guidance**, the accuracy, validity, and usefulness of any BCA depend on the correctness of the input data. A **BCA** in which **ANY** of the input data do not realistically reflect the particulars of the building and mitigation project under evaluation will be inaccurate and potentially misleading.

As discussed in Chapter 5, many of the data inputs for BCAs are not exact numbers, but rather informed estimates or judgements. Nevertheless, all of the data inputs as well as the results must be reviewed for reasonableness and defensibility.

BCAs are subject to review and audit. Therefore, any analyses where the input parameters are not reasonable for the specific building and mitigation project under evaluation may be challenged.

HELPFUL HINTS:

ALL data inputs for BCAs MUST be reasonable and defensible. Otherwise, BCRs will be invalid.

The analyst has full control over the data inputs and thus full responsibility for the benefit-cost results.

Next Screen

Click on the **NEXT SCREEN** button to proceed to the **SUMMARY** screen.

SUMMARY

The **Summary** screen of the BC Results contains three parts:

1. Summary of the individual data used for the analysis.
2. Table of all data entries that vary by flood depth from –2 to +8 feet or greater.
3. Summary of the BC Results.

The three sections of the **Summary Table** are shown below:

Individual Data Used for this Analysis

DATA USED FOR THIS ANALYSIS:	
Building Replacement Value ($/sf)	$75.00
Total Floor Area (square feet):	2,000
Total Building Replacement Value:	$150,000
Demolition Threshold Damage Percentage:	50%
Total Contents Value	$50,000
Total Displacement Costs ($/month):	$2,750
One-Time Displacement Costs($)	$1,500
Cost of Providing Services from this Building ($/day)	$563
Post-Disaster Continuity Premium ($/day)	$500
Total Value of Lost Services ($/day)	$1,063
Total Monthly Rent from All Tenants ($/month)	$500
Estimated Net Income of Commercial Businesses ($/month)	$1,500
Total Mitigation Project Costs	$53,205
Discount Rate	7.00%
Project Useful Life (years)	30

Data That Vary By Flood Depth

DATA THAT VARY BY FLOOD DEPTH:

Flood Depth (ft)	Building DDF (%)	Modified DDF (%)	Contents DDF (%)	Displacement Time (days)	Functional Downtime (days)	Building Mit. Effectiveness (%)	Contents Mit. Effectiveness (%)	Annual # of Floods
-2	0	0	0	0	0	N/A	N/A	5.321E-01
-1	0	0	0	0	0	N/A	N/A	1.336E-01
0	5	5	7.5	0	5	100.00%	100.00%	4.926E-02
1	9	9	13.5	0	9	100.00%	100.00%	2.072E-02
2	13	13	19.5	54	13	100.00%	100.00%	1.225E-02
3	18	18	27	94	18	100.00%	100.00%	3.691E-03
4	20	20	30	110	20	100.00%	100.00%	1.223E-03
5	22	22	33	126	22	77.27%	77.27%	4.497E-04
6	24	24	36	142	24	62.50%	62.50%	1.801E-04
7	26	26	39	158	26	50.00%	50.00%	7.753E-05
8	29	29	43.5	182	29	37.93%	37.93%	3.547E-05
>8	33	33	49.5	214	30	33.33%	33.33%	3.630E-05

Summary of Benefit and Cost Data

SUMMARY OF PROJECT BENEFITS AND COSTS		
PROJECT BENEFITS		$30,999
PROJECT COSTS	GRAPH	$53,205
BENEFITS MINUS COSTS		($22,205)
BENEFIT-COST RATIO		0.58

CHAPTER 10
BENEFIT-COST PROGRAM: PRINT-OUT

The print-out of the **Benefit-Cost (BC) Program** contains all data tables, results tables, and graphs from the **BC Program**. The print-out consists of three parts:

1. A one-page summary of the data inputs.
2. A 12-page report containing all of the data entry and results pages from the BC Program.
3. Five pages of graphs illustrating flood hazards, damages, and BC results.

RIVERINE FLOOD

Full Data Module

Version 5.2.3
March 10, 1999

Report of Benefit-Cost Analysis

Building Name	City Office Annex
Address	55 A Street Alworth, VA 22222
Project Description	Elevate 5 feet
Project Number	1234
Application Date	March 6, 1999
Scenario Run ID	2
Analyst	R. Johnson

LEVEL ONE DATA

PROJECT INFORMATION

Building Name	City Office Annex
Address	55 A Street
City, State, Zip	Alworth, VA 22222
Owner	City of Alworth
Contact Person	Sam Smith, City Manager
Disaster Number	FEMA-XXXX-VA
Project Number	1234
Application Date	March 6, 1999
Discount Rate	7.00%
Scenario Run ID	2
Analyst	R. Johnson

BUILDING DATA

Building Type Selected: 2 Story w/o Basement

BUILDING INFORMATION

First Floor Elevation (elevation in feet above sea level)	6
Number of Stories Above Grade	2
Construction Date	1965
Historic Building Controls	No

BUILDING SIZE AND USE

Total Floor Area (sf)	2,000
Area Occupied by Owner or Public/Nonprofit Agencies (sf)	1,500

BUILDING VALUE

Building Replacement Value ($/sf)		$75.00
Total Building Replacement Value ($)		$150,000
Building Damage that would Result in Demolition	Percent	50
	Value	$75,000

BUILDING CONTENTS

Contents Description	Office furniture, computers & files
Total Value of Contents($)	$50,000
Value of Contents ($/sf)	$25.00

DISPLACEMENT COSTS DUE TO FLOOD DAMAGE

Rental Cost of Temporary Building Space ($/sf/month)	$1.50
Rental Cost of Temporary Building Space ($/month)	$2,250
Other Costs of Displacement ($/month)	$500
Total Displacement Costs ($/month)	$2,750
One-Time Displacement Costs($)	$1,500

LEVEL ONE DATA (Continued) Page 2

City Office Annex | 55 A Street | Alworth, VA 22222

Analyst: R. Johnson | Scenario Run ID: 2

VALUE OF PUBLIC/NONPROFIT SERVICES

Description of Services Provided	City Planning Office
Annual Budget of Public/Nonprofit Agencies	$195,000
Is Rent Included in this Budget?	Rent Not Included
If Rent is NOT Included, a Proxy Rent is Added to the Budget ($/month)	$875
User-Entered Rent Estimate, in Place of Proxy Rent ($/month)	$0
Cost of Providing Services from this Building ($/day)	$563
Post-Disaster Continuity Premium ($/day)	$500
Total Value of Lost Services ($/day)	$1,063

RENT & BUSINESS INCOME

Total Monthly Rent from All Tenants ($/month)	$500
Estimated Net Income of Commercial Businesses ($/month)	$1,500

MITIGATION PROJECT DATA

		HOW MANY FEET IS THE FFE BEING RAISED?
Type of Mitigation Selected	Elevation	5.0
Project Description	Elevate 5 feet	
Project Useful Life (years)		30
Mitigation Project Cost (excluding relocation costs)		$40,000
Base Year of Costs		1999
Annual Maintenance Costs ($/year)		$500
Present Value of Annual Maintenance Costs ($)		$6,205
Relocation Costs for Mitigation Project		
Relocation Time Due to Project (months)		2
Rental Cost during Occupant Relocation ($/sf/month)		$2.00
Rental Cost during Occupant Relocation ($/month)		$3,000
Other Relocation Costs ($/month)		$500
Total Relocation Costs		$7,000
Total Mitigation Project Costs		$53,205

FLOOD HAZARD DATA Page 3

City Office Annex | 55 A Street | Alworth, VA 22222

Analyst: R. Johnson | Scenario Run ID: 2

REFERENCE INFORMATION FROM LEVEL ONE DATA

Elevation of Lowest Finished Floor above Sea Level (feet): 6

FLOOD HAZARD DATA

Data from Flood Insurance Study (FIS)

Flood Frequency (years)	Discharge (cfs)	Elevation (ft)
10	279,000	5.3
50	361,000	7.4
100	377,000	8
500	444,000	9.5

EXPECTED ANNUAL NUMBER OF FLOODS

Flood Depth (feet)	Default Value	User - Entered Value
-2	5.32E-01	
-1	1.34E-01	
0	4.93E-02	
1	2.07E-02	
2	1.22E-02	
3	3.69E-03	
4	1.22E-03	
5	4.50E-04	
6	1.80E-04	
7	7.75E-05	
8	3.55E-05	
>8	3.63E-05	

DATA SOURCES AND DOCUMENTATION

LEVEL TWO DATA: BUILDING DEPTH-DAMAGE FUNCTION

City Office Annex | 55 A Street | Alworth, VA 22222

Analyst: R. Johnson | Scenario Run ID: 2

REFERENCE INFORMATION FROM LEVEL ONE DATA

Building Type:	2 Story w/o Basement
Number of Stories Above Grade	2
Construction Date	1965
Historic Building Controls	No
Total Floor Area (square feet):	2,000
Total Building Replacement Value:	$150,000
Demolition Threshold Damage Percentage:	50%

BUILDING DEPTH-DAMAGE FUNCTION (DDF) - BEFORE MITIGATION

Flood Depth (feet)	ESTIMATED BUILDING DAMAGE			
	Default DDF (%)	User-Entered DDF (%)	Modified DDF (%)	Modified DDF ($)
-2	0		0	$0
-1	0		0	$0
0	5		5	$7,500
1	9		9	$13,500
2	13		13	$19,500
3	18		18	$27,000
4	20		20	$30,000
5	22		22	$33,000
6	24		24	$36,000
7	26		26	$39,000
8	29		29	$43,500
>8	33		33	$49,500

Flood Depth (feet)	ESTIMATED BUILDING DAMAGE			
	Default DDF (%)	User-Entered DDF (%)	Modified DDF (%)	Modified DDF ($)
-2	0		0	$0
-1	0		0	$0
0	0		0	$0
1	0		0	$0
2	0		0	$0
3	0		0	$0
4	0		0	$0
5	5		5	$7,500
6	9		9	$13,500
7	13		13	$19,500
8	18		18	$27,000
>8	22		22	$33,000

DATA SOURCES AND DOCUMENTATION

LEVEL TWO DATA: CONTENTS DEPTH-DAMAGE FUNCTION

Page 5

City Office Annex	55 A Street	Alworth, VA 22222

Analyst: R. Johnson Scenario Run ID: 2

REFERENCE INFORMATION FROM LEVEL ONE DATA

Contents Description	Office furniture, computers & files
Total Value of Contents($)	$50,000
Value of Contents ($/sf)	$25.00

CONTENTS DEPTH-DAMAGE FUNCTION (DDF)

Flood Depth (feet)	Building DDF(%)	ESTIMATED CONTENTS DAMAGE - BEFORE		
		Default DDF (%)	User-Entered DDF (%)	Contents DDF ($)
-2	0	0		$0
-1	0	0		$0
0	5	8		$3,750
1	9	14		$6,750
2	13	20		$9,750
3	18	27		$13,500
4	20	30		$15,000
5	22	33		$16,500
6	24	36		$18,000
7	26	39		$19,500
8	29	44		$21,750
>8	33	50		$24,750

Flood Depth (feet)	Building DDF(%)	ESTIMATED CONTENTS DAMAGE - AFTER		
		Default DDF (%)	User-Entered DDF (%)	Contents DDF ($)
-2	0	0		$0
-1	0	0		$0
0	0	0		$0
1	0	0		$0
2	0	0		$0
3	0	0		$0
4	0	0		$0
5	5	8		$3,750
6	9	14		$6,750
7	13	20		$9,750
8	18	27		$13,500
>8	22	33		$16,500

DATA SOURCES AND DOCUMENTATION

LEVEL TWO DATA: DISPLACEMENT TIME Page 6

City Office Annex | 55 A Street | Alworth, VA 22222

Analyst: R. Johnson | Scenario Run ID: 2

REFERENCE INFORMATION FROM LEVEL ONE DATA

Rental Cost of Temporary Building Space ($/sf/month)	$1.50
Rental Cost of Temporary Building Space ($/month)	$2,250
Other Costs of Displacement ($/month)	$500
Total Displacement Costs ($/month)	$2,750
Total Monthly Rent from All Tenants ($/month)	$500

DISPLACEMENT TIME DUE TO BUILDING FLOOD DAMAGE

BEFORE MITIGATION

Flood Depth (feet)	Modified DDF (%)	Default (days)	User-Entered (days)	Displacement Costs	Rental Income Losses
-2	0	0		$0	$0
-1	0	0		$0	$0
0	5	0		$0	$0
1	9	0		$0	$0
2	13	54		$6,450	$900
3	18	94		$10,117	$1,567
4	20	110		$11,583	$1,833
5	22	126		$13,050	$2,100
6	24	142		$14,517	$2,367
7	26	158		$15,983	$2,633
8	29	182		$18,183	$3,033
>8	33	214		$21,117	$3,567

AFTER MITIGATION

Flood Depth (feet)	Modified DDF (%)	Default (days)	User-Entered (days)	Displacement Costs	Rental Income Losses
-2	0	0		$0	$0
-1	0	0		$0	$0
0	0	0		$0	$0
1	0	0		$0	$0
2	0	0		$0	$0
3	0	0		$0	$0
4	0	0		$0	$0
5	5	0		$0	$0
6	9	0		$0	$0
7	13	54		$6,450	$900
8	18	94		$10,117	$1,567
>8	22	126		$13,050	$2,100

DATA SOURCES AND DOCUMENTATION

LEVEL TWO DATA: FUNCTIONAL DOWNTIME

City Office Annex	55 A Street	Alworth, VA 22222

Analyst: R. Johnson Scenario Run ID: 2

REFERENCE INFORMATION FROM LEVEL ONE DATA

Cost of Providing Services from this Building ($/day)	$563
Post-Disaster Continuity Premium ($/day)	$500
Total Value of Lost Services ($/day)	$1,063
Estimated Net Income of Commercial Businesses ($/month)	$1,500

FUNCTIONAL DOWNTIME ESTIMATES

BEFORE MITIGATION

Flood Depth (feet)	Building DDF (%)	Default Downtime (days)	User-Entered Downtime (days)	Value of Lost Services	Lost Business Income
-2	0	0		$0	$0
-1	0	0		$0	$0
0	5	5		$5,315	$250
1	9	9		$9,567	$450
2	13	13		$13,819	$650
3	18	18		$19,134	$900
4	20	20		$21,260	$1,000
5	22	22		$23,386	$1,100
6	24	24		$25,512	$1,200
7	26	26		$27,638	$1,300
8	29	29		$30,827	$1,450
>8	33	30		$31,890	$1,500

AFTER MITIGATION

Flood Depth (feet)	Building DDF (%)	Default Downtime (days)	User-Entered Downtime (days)	Value of Lost Services	Lost Business Income
-2	0	0		$0	$0
-1	0	0		$0	$0
0	0	0		$0	$0
1	0	0		$0	$0
2	0	0		$0	$0
3	0	0		$0	$0
4	0	0		$0	$0
5	5	5		$5,315	$250
6	9	9		$9,567	$450
7	13	13		$13,819	$650
8	18	18		$19,134	$900
>8	22	22		$23,386	$1,100

DATA SOURCES AND DOCUMENTATION

SUMMARY OF DAMAGES BEFORE MITIGATION

City Office Annex | 55 A Street | Alworth, VA 22222

Analyst: R. Johnson
Scenario Run ID: 2
Building Type: 2 Story w/o Basement
Project Description: Elevate 5 feet

SCENARIO DAMAGES BEFORE MITIGATION ($ per event)

Flood Depth	Building Damages	Contents Damages	Displacement Costs	Business Losses	Rental Losses	Public/ Nonprofit	Total
-2	$0	$0	$0	$0	$0	$0	$0
-1	$0	$0	$0	$0	$0	$0	$0
0	$7,500	$3,750	$0	$250	$0	$5,315	$16,815
1	$13,500	$6,750	$0	$450	$0	$9,567	$30,267
2	$19,500	$9,750	$6,450	$650	$900	$13,819	$51,069
3	$27,000	$13,500	$10,117	$900	$1,567	$19,134	$72,218
4	$30,000	$15,000	$11,583	$1,000	$1,833	$21,260	$80,677
5	$33,000	$16,500	$13,050	$1,100	$2,100	$23,386	$89,136
6	$36,000	$18,000	$14,517	$1,200	$2,367	$25,512	$97,596
7	$39,000	$19,500	$15,983	$1,300	$2,633	$27,638	$106,055
8	$43,500	$21,750	$18,183	$1,450	$3,033	$30,827	$118,744
>8	$49,500	$24,750	$21,117	$1,500	$3,567	$31,890	$132,324

EXPECTED ANNUAL DAMAGES BEFORE MITIGATION ($ per year)

Flood Depth	Building Damages	Contents Damages	Displacement Costs	Business Losses	Rental Losses	Public/ Nonprofit	Total
-2	$0	$0	$0	$0	$0	$0	$0
-1	$0	$0	$0	$0	$0	$0	$0
0	$369	$185	$0	$12	$0	$262	$828
1	$280	$140	$0	$9	$0	$198	$627
2	$239	$119	$79	$8	$11	$169	$625
3	$100	$50	$37	$3	$6	$71	$267
4	$37	$18	$14	$1	$2	$26	$99
5	$15	$7	$6	$0	$1	$11	$40
6	$6	$3	$3	$0	$0	$5	$18
7	$3	$2	$1	$0	$0	$2	$8
8	$2	$1	$1	$0	$0	$1	$4
>8	$2	$1	$1	$0	$0	$1	$5
Total	$1,052	$526	$142	$35	$21	$745	$2,521

SUMMARY OF DAMAGES AFTER MITIGATION Page 9

City Office Annex | 55 A Street | Alworth, VA 22222

Analyst: R. Johnson | Scenario Run ID: 2

Building Type: 2 Story w/o Basement

Project Description: Elevate 5 feet

SCENARIO DAMAGES AFTER MITIGATION ($ per event)

Flood Depth	Building Damages	Contents Damages	Displacement Costs	Business Losses	Rental Losses	Public/ Nonprofit	Total
-2	$0	$0	$0	$0	$0	$0	$0
-1	$0	$0	$0	$0	$0	$0	$0
0	$0	$0	$0	$0	$0	$0	$0
1	$0	$0	$0	$0	$0	$0	$0
2	$0	$0	$0	$0	$0	$0	$0
3	$0	$0	$0	$0	$0	$0	$0
4	$0	$0	$0	$0	$0	$0	$0
5	$7,500	$3,750	$0	$250	$0	$5,315	$16,815
6	$13,500	$6,750	$0	$450	$0	$9,567	$30,267
7	$19,500	$9,750	$6,450	$650	$900	$13,819	$51,069
8	$27,000	$13,500	$10,117	$900	$1,567	$19,134	$72,218
>8	$33,000	$16,500	$13,050	$1,100	$2,100	$23,386	$89,136

EXPECTED ANNUAL DAMAGES AFTER MITIGATION ($ per year)

Flood Depth	Building Damages	Contents Damages	Displacement Costs	Business Losses	Rental Losses	Public/ Nonprofit	Total
-2	$0	$0	$0	$0	$0	$0	$0
-1	$0	$0	$0	$0	$0	$0	$0
0	$0	$0	$0	$0	$0	$0	$0
1	$0	$0	$0	$0	$0	$0	$0
2	$0	$0	$0	$0	$0	$0	$0
3	$0	$0	$0	$0	$0	$0	$0
4	$0	$0	$0	$0	$0	$0	$0
5	$3	$2	$0	$0	$0	$2	$8
6	$2	$1	$0	$0	$0	$2	$5
7	$2	$1	$1	$0	$0	$1	$4
8	$1	$0	$0	$0	$0	$1	$3
>8	$1	$1	$0	$0	$0	$1	$3
Total	$9	$5	$1	$0	$0	$7	$23

SUMMARY OF BENEFITS FROM MITIGATION Page 10

City Office Annex | 55 A Street | Alworth, VA 22222

Analyst: R. Johnson | Scenario Run ID: 2

Building Type: 2 Story w/o Basement

Project Description: Elevate 5 feet

EXPECTED ANNUAL BENEFITS FROM MITIGATION ($ per year)

Flood Depth	Building Damages	Contents Damages	Displacement Costs	Business Losses	Rental Losses	Public/ Nonprofit	Total
-2	$0	$0	$0	$0	$0	$0	$0
-1	$0	$0	$0	$0	$0	$0	$0
0	$369	$185	$0	$12	$0	$262	$828
1	$280	$140	$0	$9	$0	$198	$627
2	$239	$119	$79	$8	$11	$169	$625
3	$100	$50	$37	$3	$6	$71	$267
4	$37	$18	$14	$1	$2	$26	$99
5	$11	$6	$6	$0	$1	$8	$33
6	$4	$2	$3	$0	$0	$3	$12
7	$2	$1	$1	$0	$0	$1	$4
8	$1	$0	$0	$0	$0	$0	$2
>8	$1	$0	$0	$0	$0	$0	$2
Total	$1,042	$521	$140	$35	$21	$739	$2,498

BENEFIT-COST RESULTS Page 11

City Office Annex | 55 A Street | Alworth, VA 22222

Analyst	R. Johnson	Scenario Run ID	2
Building Type	2 Story w/o Basement		
Project Description	Elevate 5 feet		

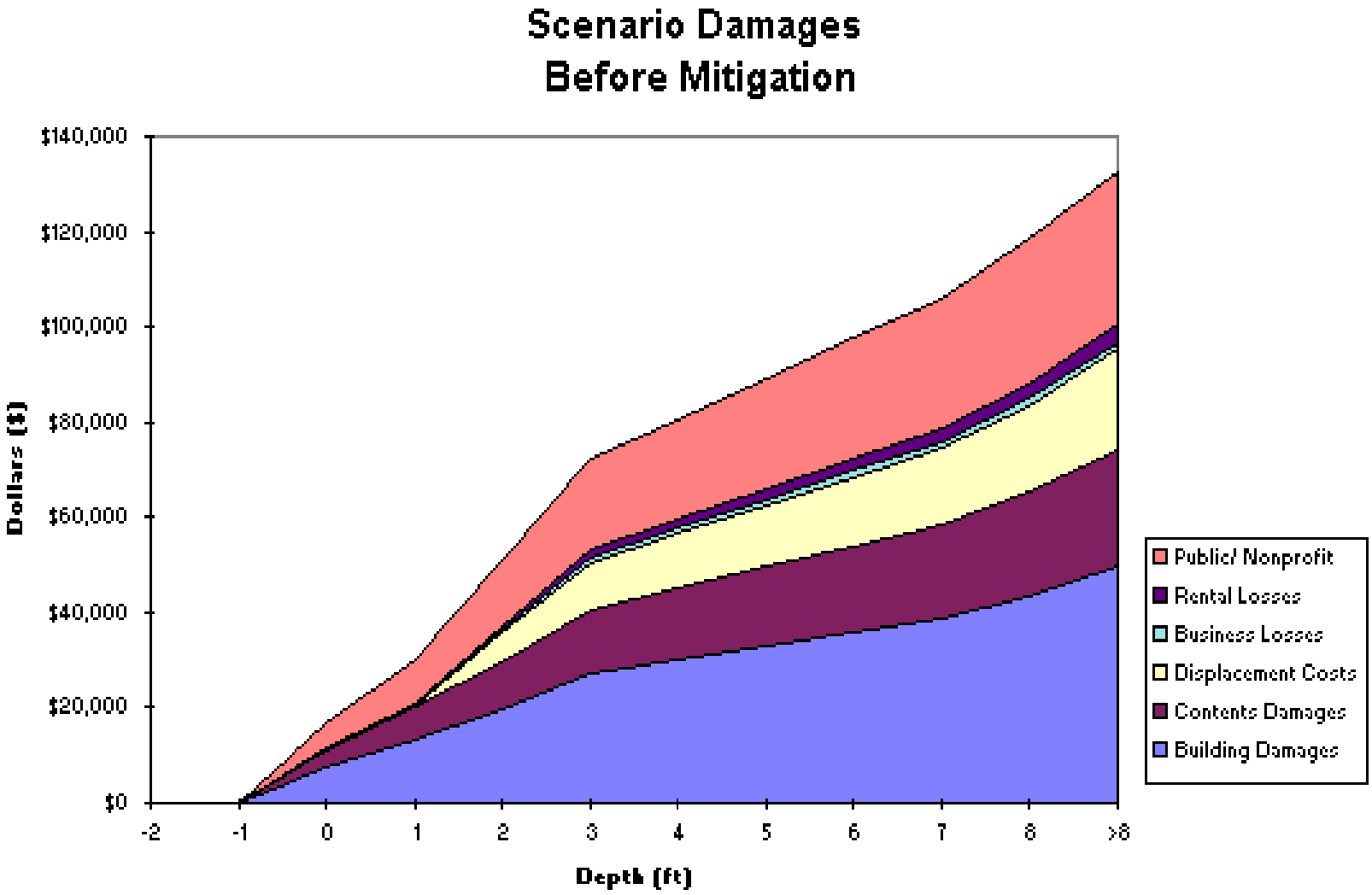
Discount Rate	7.00%
Project Useful Life (years)	30
Present Value Coefficient	12.41

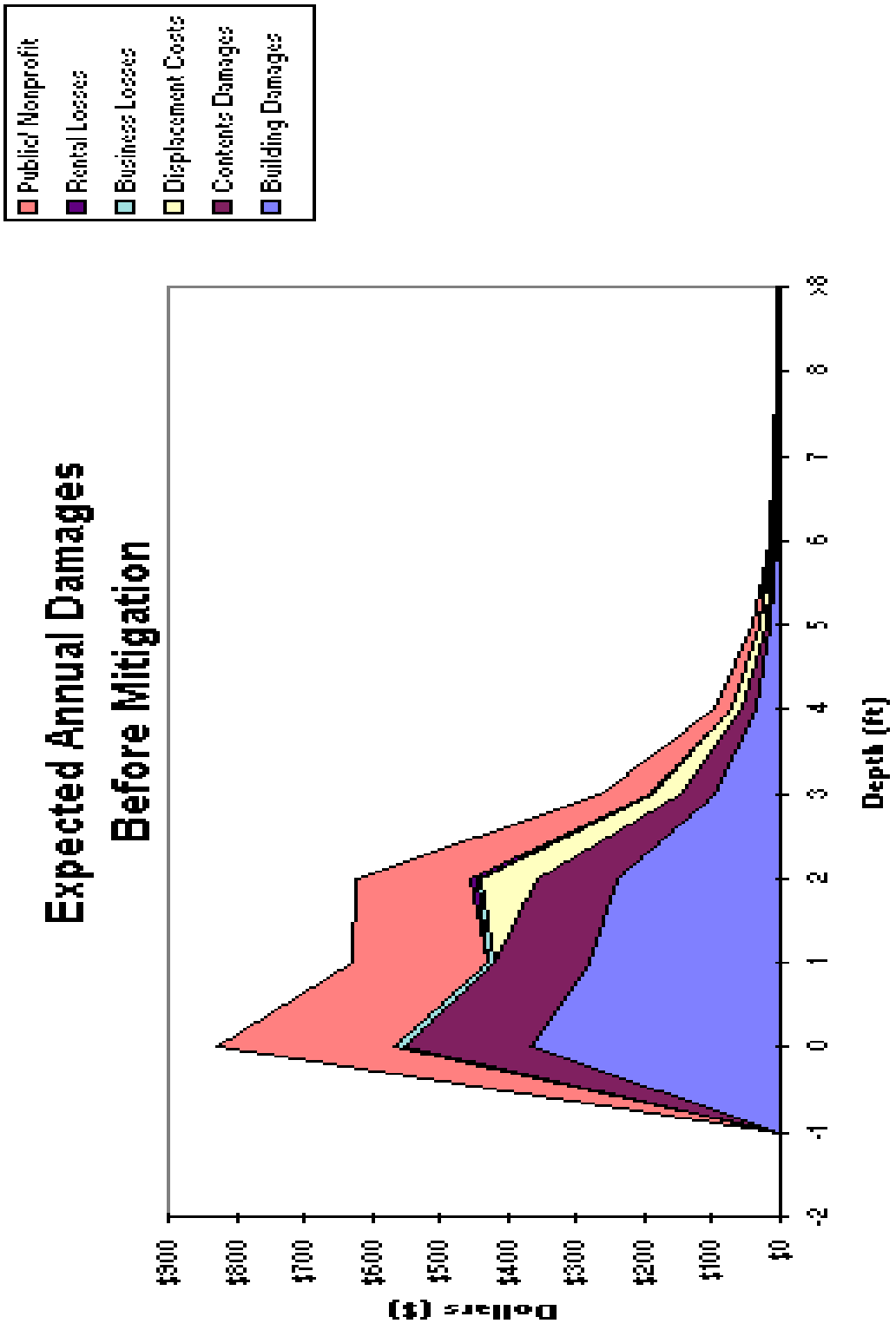
SUMMARY OF EXPECTED DAMAGES AND BENEFITS

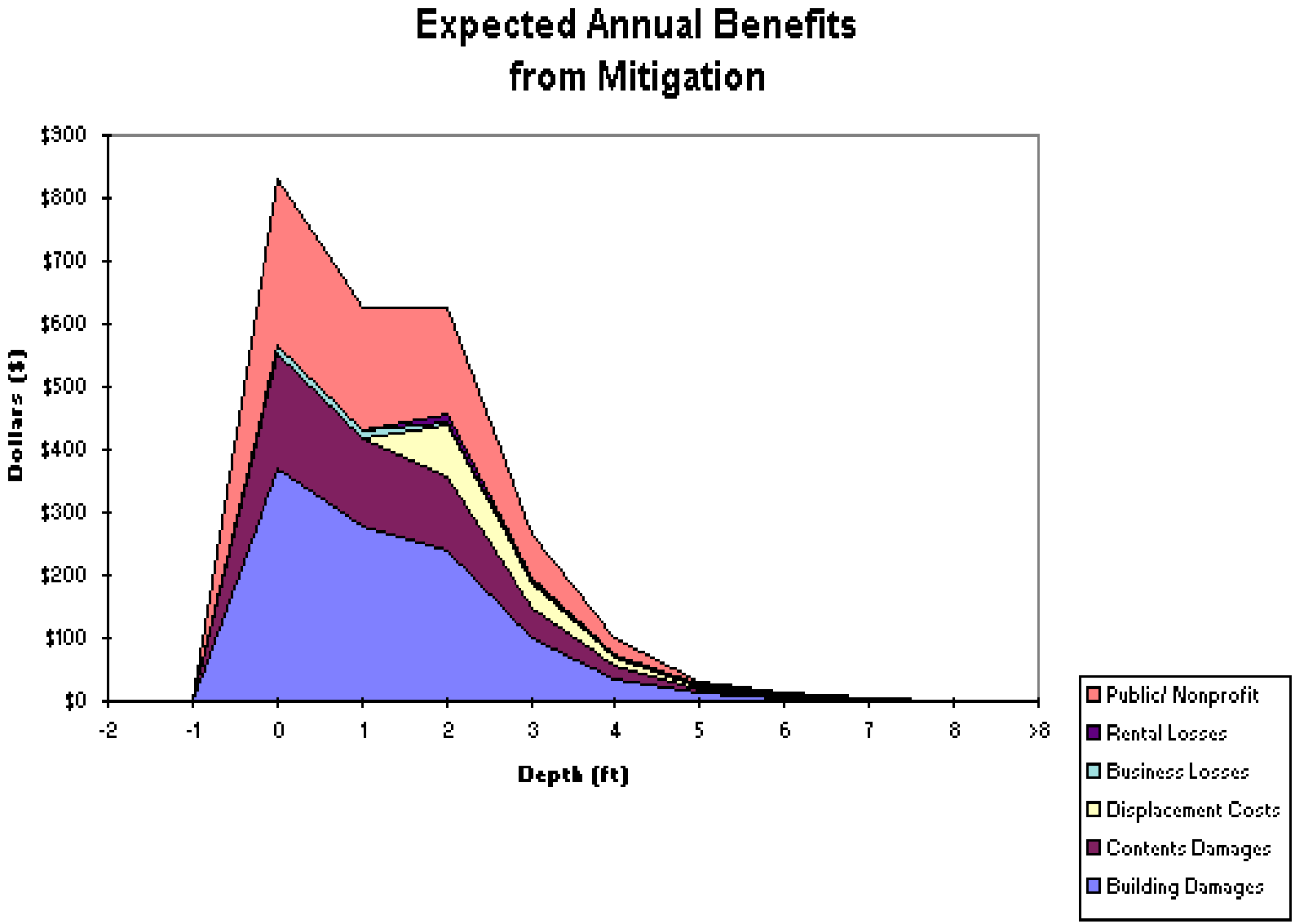
	Expected Annual Damages Before Mitigation	Expected Annual Damages After Mitigation	Expected Annual Benefits	Present Value of Annual Benefits
Building Damages	$1,052	$9	$1,042	$12,936
Contents Damages	$526	$5	$521	$6,468
Displacement Costs	$142	$1	$140	$1,741
Business Income Lost	$35	$0	$35	$431
Rental Income Lost	$21	$0	$21	$256
Public Services Lost	$745	$7	$739	$9,166
Total Losses & Benefits	$2,521	$23	$2,498	$30,999

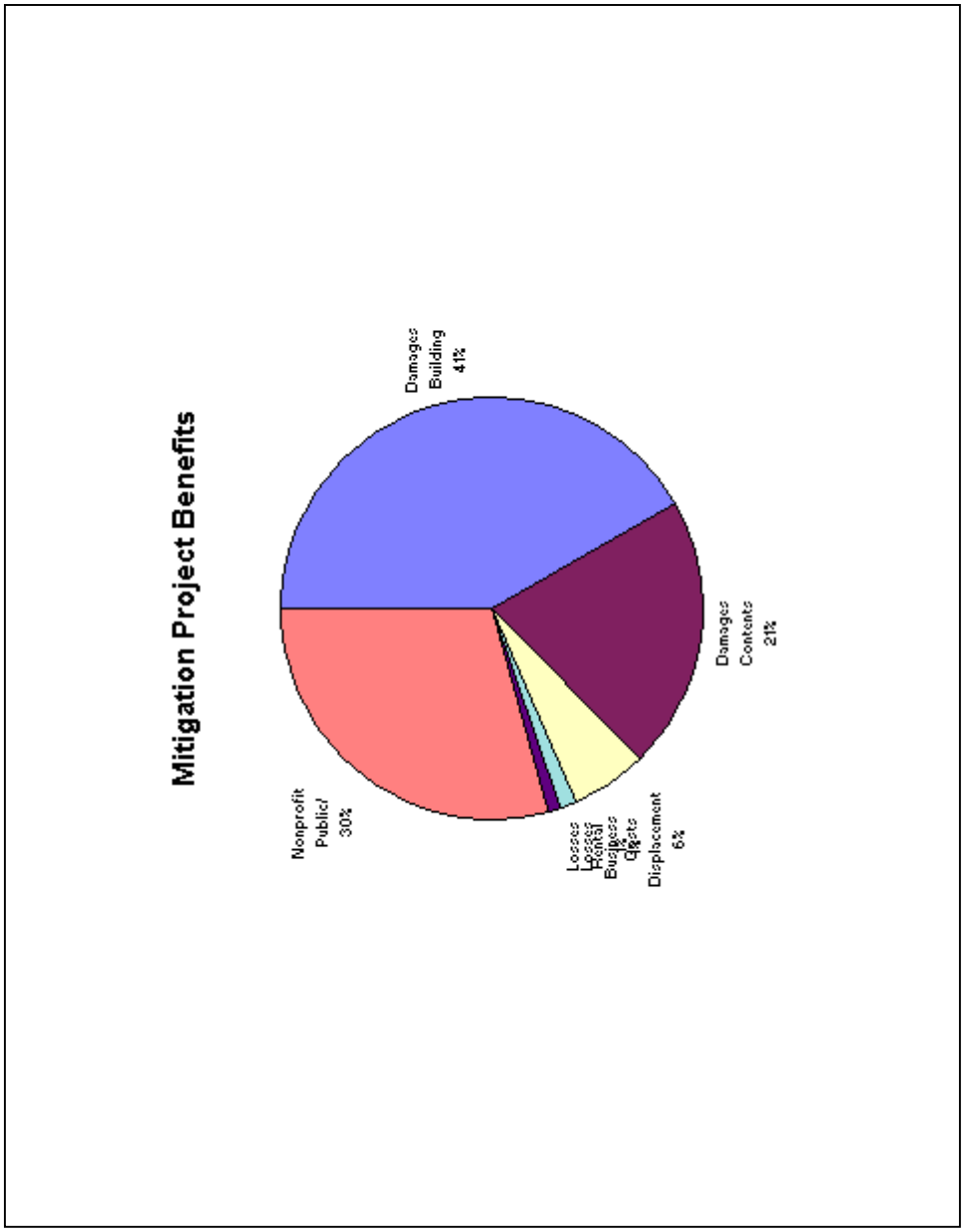
PROJECT BENEFITS	**$30,999**
PROJECT COSTS	**$53,205**
BENEFITS MINUS COSTS	**($22,205)**
BENEFIT-COST RATIO	**0.58**

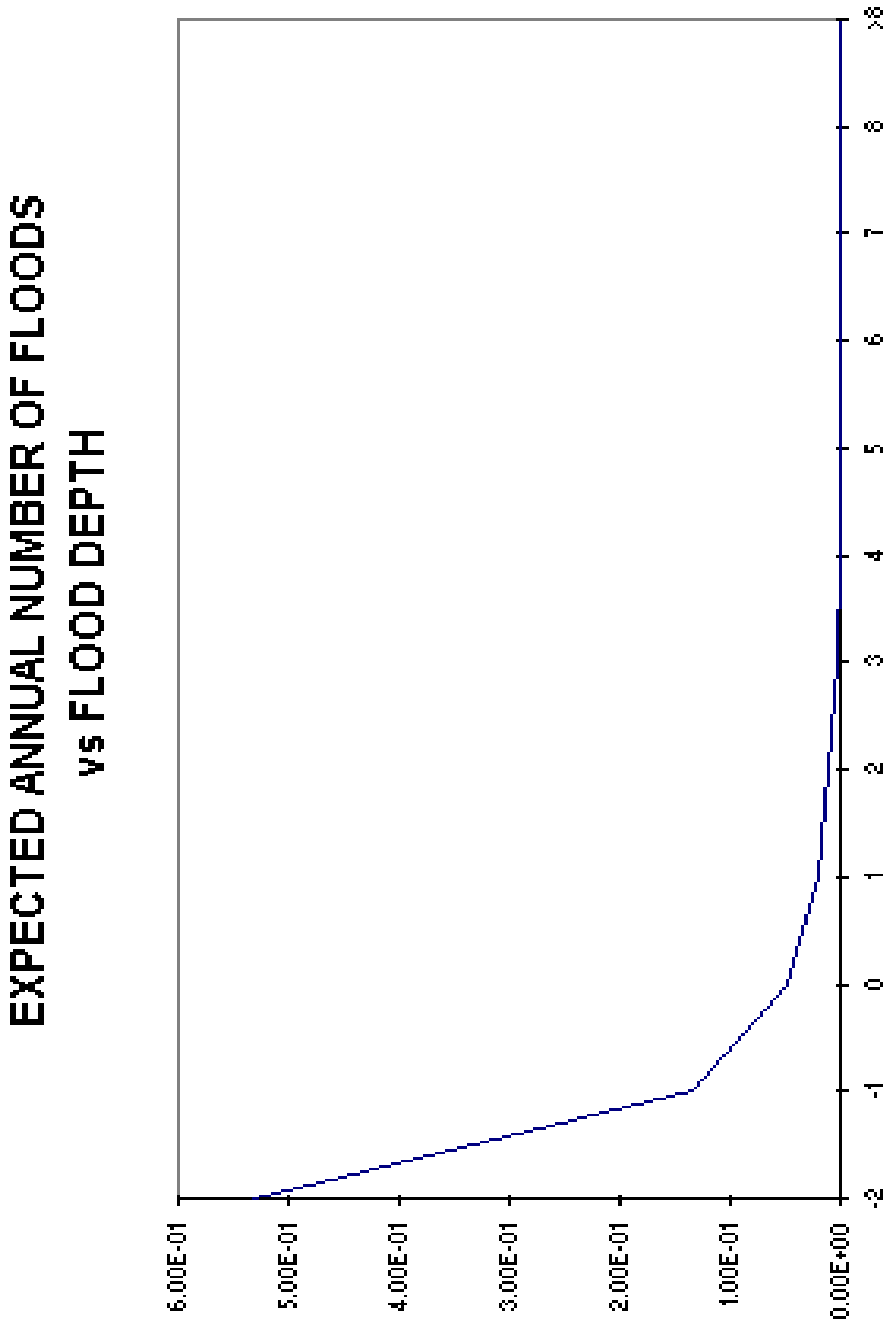
FEMA Disclaimer: The results produced by this analysis are neither conclusive evidence that the proposed project is cost-effective, nor a guarantee that a project is eligible for any government grant for whatever purpose.


Scenario Damages
Before Mitigation
$140,000
$120,000
$100,000
$80,000
$60,000
$40,000
$20,000
$0
Dollars ($)
-2
-1
0
1
2
3
4
5
6
7
8
>8
Depth (ft)
Public/ Nonprofit
Rental Losses
Business Losses
Displacement Costs
Contents Damages
Building Damages


Public/ Nonprofit
Rental Losses
Business Losses
Displacement Costs
Contents Damages
Building Damages
Expected Annual Damages
Before Mitigation
Dollars ($)
$900
$800
$700
$600
$500
$400
$300
$200
$100
$0
-2
-1
0
1
2
3
4
5
6
7
8
>8
Depth (ft)


Expected Annual Benefits
from Mitigation
$900
$800
$700
$600
$500
$400
$300
$200
$100
$0
Dollars ($)
-2
-1
0
1
2
3
4
5
6
7
8
>8
Depth (ft)
Public/ Nonprofit
Rental Losses
Business Losses
Displacement Costs
Contents Damages
Building Damages


Mitigation Project Benefits
Damages Building 41%
Damages Contents 21%
Displacement 6%
Losses Loss of Business 2%
Nonprofit Public 30%


EXPECTED ANNUAL NUMBER OF FLOODS
vs FLOOD DEPTH
6.00E-01
5.00E-01
4.00E-01
3.00E-01
2.00E-01
1.00E-01
0.00E+00
-2
-1
0
1
2
3
4
5
6
7
8
>8

CHAPTER 11
GLOSSARY

Annual Budget of Public/Nonprofit Agencies	The annual budget of public/nonprofit agencies is the total annual operating budget of all the public/nonprofit agency functions located in a building, excluding "pass-through" monies (e.g., Social Security payments) which the agency receives and redistributes. The annual budget is used to value the loss of public/nonprofit services due to flood damages.
Avoided Damages and Losses	Avoided damages and losses are the "benefits" counted in Benefit-Cost Analysis (BCA). Six types of avoided damages and losses are counted in this Benefit-Cost (BC) Program: building damages, contents damages, displacement costs, business income losses, rental income losses, and lost public/nonprofit services.
Base Year of Costs	The base year of costs is the year in which the mitigation project costs were estimated and allows cost estimates made in prior years to be adjusted for any inflation in costs between the base year and the present time.
Benefit-Cost Ratio (BCR)	The Benefit-Cost Ratio (BCR) is the ratio of the present value of benefits to project costs for a proposed mitigation project.
Benefits	The benefits counted in a Benefit-Cost Analysis (BCA) are the present value of the sum of the expected annual avoided damages over the lifetime of the mitigation project.
Block Colors	See **Cell Colors**.
Building Damages	Building damages are the estimated damages to a structure, expressed as a percentage of the building's replacement value. Building damages include both structural and non-structural elements (mechanical, electrical, and plumbing systems) but exclude the building's contents.
Building Depth-Damage Function (BDDF)	The Building Depth-Damage Function (BDDF) indicates the building's vulnerability to flood damage by showing the estimated building damage for the range of flood depths from -2 to +8 feet or greater from the top of the lowest finished floor. See **Finished Floor Elevation (FFE)**.

Building Replacement Value	Building replacement value is the cost to provide a functionally-equivalent structure of the same size, generally of a more modern construction type. Replacement value does not include recreating historical or archaic materials, finishes, or features.
Building Reproduction Value	Building reproduction value is the cost of duplicating the design and architectural details of a specific, usually historic, building.
Building Type	Building types considered in the program are the six Federal Insurance Administration (FIA) building types (1 story without basement, 2 story without basement, and split level without basement; 1 or 2 story with basement, split level with basement; and mobile home) plus an "other" category. The "other" category allows data inputs for building types not covered by the six FIA building types.
Building-Specific Data	Building-specific data are values that apply to the specific building under evaluation rather than to a generic building construction type.
Business Income Losses	Business income losses are the value of lost net business income due to flood damage.
Buyout (Mitigation Measure)	Buyout (a.k.a. acquisition) is a type of mitigation measure in which the owner's interest in the building is purchased and the building demolished. Buyouts are assumed to be 100% effective mitigation measures at all flood depths.
Cell Color Codes	Each cell (block) of data entry or data display areas of the program screens is color coded to inform the user what type of information each block contains. The seven cell colors used in the BC Program indicate different types of entries: **BROWN Blocks (Default)** contain default data that vary depending on the building type selected and other user-determined inputs. **DARK BLUE Block (OMB Policy)** contains the discount rate that is defined by OMB or FEMA policy and thus is not a user-defined entry. **GREEN Blocks (Data Input)** require the analyst to enter data concerning the building or project and directly affect the calculated results. **LIGHT BLUE Blocks (Override Default)** can be used to override default data with project-specific data. **PINK Blocks (Information Only)** contain information about the building or project and do not affect the calculated results. **PURPLE Blocks (Carry Over)** contain information that was entered by the user in other screens. **YELLOW Blocks (Results)** contain calculated results from the BC Program.

Coastal Transect	Used in the Coastal-A Zone and Coastal-V Zone programs (but not in the Riverine Flood program), a coastal transect is a line drawn perpendicular to the coastline showing the A-Zone and V-Zone regions. Coastal transects are shown on maps in coastal Flood Insurance Studies.
Construction Date	The construction date is the year during which the building's construction was started.
Contents Damages	Contents damages are the estimated damages to the building contents, expressed as a percentage of the total contents' replacement value. Contents damages include furniture, office equipment, carpet, and other items specific to individual tenants' usage, but exclude mechanical, electrical, and plumbing systems which are non-structural parts of the building.
Contents Depth-Damage Function (CDDF)	The Contents Depth-Damage Function (CDDF) indicates the content's vulnerability to flood damage by showing the estimated contents damage for the range of flood depths from -2 to +8 feet or greater from the top of the lowest finished floor. See **Finished Floor Elevation (FFE)**.
Contents Value	The contents value is the estimated total value of the building's contents, including furniture, carpet, equipment, supplies, etc.
Continuity Premium	The post-disaster continuity premium is a means of more highly valuing public/nonprofit services that are particularly important in the post-disaster environment. The continuity premium is the extra dollar amount per day an agency would be willing to pay to maintain its functions after a flood. This premium is appropriate for those public/nonprofit services that may be more valuable than normal in the post-flood time period.
Cost of Occupant Displacement	The cost of occupant displacement is the total cost of displacement after a flood, including rent for temporary quarters, moving, and extra operating costs incurred because of displacement. The total cost of displacement of occupants is calculated from the displacement time and cost per month.
Default Building Depth-Damage Function (DDF)	The default building Depth-Damage Function (DDF) indicates a typical building's vulnerability to flood damage by showing the estimated levels of damage at each flood depth, based on the building type selected.
Default Values	Default, or reference, values are the estimated "typical" values contained in the program which are used in a **Level One (Minimum Data)** analysis to facilitate a benefit-cost analysis for a "typical" building of the type selected.
Demolition Threshold Damage Percentage	The demolition threshold damage percentage is the level of building damage, expressed as a percentage of the building's replacement value, at which the building is likely to be demolished rather than repaired. This percentage will vary depending on the type, style, age, condition, and historic significance of the structure.

Depth-Damage Function (DDF)	See **Building Depth-Damage Function (BDDF)** or **Contents Depth-Damage Function (CDDF)**.
Discharge	Discharge is the volume of water that will flow in a river or stream during a given time. Discharge is usually measured in cubic feet per second (cfs).
Discount Rate	The discount rate is an interest rate that accounts for the time value of money. The discount rate is used to convert expected annual benefits over the lifetime of a project to a net present value. For Federally funded hazard mitigation projects, the discount rate is determined by the Federal Office of Management and Budget (OMB) guidance.
Displacement Costs	Displacement costs are the product of displacement costs per month and the expected period for which the building will be unusable due to flood damage. Displacement costs are incurred when owners are displaced to a temporary site while flood-related damage to the original building is repaired and include costs for rent and other displacement expenses.
Displacement Time	Displacement time is the time during which occupants must operate from a temporary location due to flood-related damage while repairs are made to the original building. Compare with **Functional Downtime**.
Economic Parameters	Economic parameters used in the benefit-cost program are the **Discount Rate**, **Project Useful Life**, and **Present Value Coefficient**.
Elevation (Mitigation Measure)	Elevation is a type of mitigation measure in which an existing building is elevated above the effective 100-year flood elevation, to reduce future flood damages. Elevation measures will normally include some amount of freeboard. See Freeboard.
Estimated	"Estimated" denotes data inputs that are based on judgement rather than exact values, and also to denote calculated results derived from other input parameters. In benefit-cost analysis "estimated" is distinct from "expected." See **Expected**.
Exceedance Probability	The exceedance probability is the likelihood (probability) of exceeding a particular value in a stated time period. For example, the annual exceedance probability for a 3-foot flood is the probability for all floods greater than or equal to a 3-foot flood.
Expected	"Expected" in benefit-cost analysis means a statistical, average value. For example, "expected" annual damages are the statistical average damages "expected" over a long time period. "Expected" annual damages do not occur every year.
Expected Annual Avoided Damages	The expected annual avoided damages are the expected annual benefits counted in benefit-cost analysis. In other words, the expected annual avoided damages are the difference between expected annual damages before and after mitigation.

Expected Annual Damages After Mitigation	Expected annual damages after mitigation are the average damages per year expected over a long time period. For each flood depth, expected annual damages after mitigation are calculated by multiplying the scenario damages after mitigation by the expected annual number of floods of each depth. See **Expected Annual Number of Floods**. In this program, expected annual damages are calculated for six categories of damages and losses: building damages, contents damages, displacement costs, business income losses, rental income losses, and lost public/nonprofit services.
Expected Annual Damages Before Mitigation	Expected annual damages before mitigation are the average damages per year expected over a long time period. For each flood depth, expected annual damages are calculated by multiplying the scenario damages before mitigation by the expected annual number of floods of each depth. See **Expected Annual Number of Floods**. In this program, expected annual damages are calculated for seven categories of damages and losses: Building Damages, Contents Damages, Displacement Costs, Business Income Losses, Rental Income Losses, Lost Public/Nonprofit Services and Total Damages per Flood Depth.
Expected Annual Number of Floods	The expected annual number of floods is the long term average annual number of floods of a particular depth, from -2 to +8 feet or greater. The expected annual number of floods is closely similar to the annual probability of floods at each depth.
Expected Net Present Value	The expected net present value of a flood hazard mitigation project is the present value of benefits arising from the mitigation project. Expected annual benefits in each year of the useful lifetime of the project are discounted to present value and summed to obtain the net present value of benefits.
First Floor Elevation	The **First Floor Elevation (FFE)** of a building is the elevation, in feet above sea level, of the top of the lowest finished floor, as defined by the Federal Insurance Administration in compiling flood damage data. This does not include basements or crawl spaces.
Flood Barrier (Mitigation Measure)	A flood barrier is a type of mitigation measure in which barriers such as flood walls, levees, or enclosures are constructed to prevent flood water from reaching a structure.
Flood Depth-Damage Table	The flood depth-damage table displays the estimated damage by flood depth for the six classes of building types plus the "other" classification included in the program.
Flood Risk	The flood risk for a particular building is the expected annual number of floods, in one-foot increments from -2 to +8 feet or greater in the program, at the building site. Flood risk varies markedly with elevation. See **First Floor Elevation (FFE)**.

Freeboard

Freeboard is the additional height of a flood protection measure above an expected flood height that will provide an extra measure of flood protection. For example, to provide 100-year flood protection, levees normally are constructed 3 feet higher than the 100-year flood elevation (i.e., with 3 feet of freeboard).

Functional Downtime

Functional downtime is the time during which an agency/organization is unable to provide its services due to flood damage. Compare with **Displacement Time**.

Income, Estimated Net

The estimated net income of commercial businesses is the net monthly income of commercial businesses in the building.

Level One (Minimum Data) Benefit-Cost Analysis (BCA)

A **Level One (Minimum Data)** Benefit-Cost Analysis (BCA) uses "default" or reference data built into the program, and requires the minimum amount of building-specific and project-specific data. A **Level One** analysis may be appropriate for small, low-cost projects or as an initial screening of larger projects. See **Level Two (Detailed)** BCA.

Level Two (Detailed) Benefit-Cost Analysis (BCA)

A **Level Two (Detailed)** Benefit-Cost Analysis (BCA) is a highly detailed analysis in which default, or reference, values may be overridden with project-specific data. **Level Two** BCAs may be desirable for:

1. Large projects.
2. High-cost projects.
3. Politically sensitive projects.
4. Projects where initial screening indicates that benefit-cost ratios (BCRs) are close to 1.0.
5. Whenever the default values used in the **Level One (Minimum Data)** analysis do not accurately reflect a specific project under evaluation.
6. Where the results of a **Level One** analysis indicate that a more detailed analysis is required to determine whether the project is cost-effective.

Main Menu

The main menu is the list of headings which appears at the top of the display screen, customized for the benefit-cost program. The main menu headings in the **Benefit-Cost (BC) Program** are shown below:

Menu Bar

The menu bar displays all the main menu headings of the benefit-cost program in the row near the top of the screen (i.e., word commands), under the words "Microsoft Excel - *filename*."

Menu Tree	The menu tree is the complete list of items that can be accessed by the menu bar.
Mitigation Measure	A flood hazard mitigation measure is any project undertaken to mitigate the flood hazard. See **Elevation, Flood Barrier, Relocation**, and **Buyout**.
Mitigation Project Cost	The mitigation project cost is the sum of all direct construction costs plus other costs such as architectural and engineering fees, testing, permits, and project management but excludes relocation costs. See **Relocation Costs**.
Modified Depth-Damage Function (MDDF)	The Modified Depth-Damage Function (MDDF) is the building DDF that has been modified to account for the demolition threshold damage percentage.
Net Present Value (NPV)	See **Expected Net Present Value**.
Other (Mitigation Measure)	The "Other" category of flood hazard mitigation projects includes wet floodproofing (see previous discussion on this subject) and any other measures not covered by the **Elevation, Buyout, Relocation**, or **Flood Barrier** categories.
Planning Horizon	The planning horizon is the expected useful lifetime of the flood hazard mitigation project. See **Project Useful Life**.
Post-Disaster Continuity Premium	See **Continuity Premium**.
Present Value	See **Expected Net Present Value**.
Present Value Coefficient	The present value coefficient is a multiplier determined by the discount rate and the planning period that indicates the present value of $1.00 per year in benefits over the useful lifetime of the project. See **Expected Net Present Value**.
Present Value Criterion	The present value criterion is the difference between **Project Benefits** and **Project Costs**. This value shows the magnitude of the difference between **Benefits** and **Costs**, and may be greater than zero (if benefits exceed costs) or less than zero (if costs exceed benefits).
Project Costs	Project costs are the total mitigation project costs. See **Mitigation Project Cost**.
Project Useful Life	The project useful life is the estimated time period over which the mitigation project will maintain its effectiveness. Project useful life **must** be commensurate with the actual project being considered.
Protected Blocks	Protected blocks cannot be changed by the analyst. All uncolored (white) blocks and blocks colored orange, yellow, and purple are protected. See **Unprotected Blocks**.

Public/Nonprofit Services Lost	Public/nonprofit services lost are those services that cannot be provided when a building becomes unusable during a flood. Avoided public/nonprofit services lost are one of the benefits counted in the Benefit-Cost (BC) Program.
Recurrence Intervals	A recurrence interval is the average time period between similar events (e.g., 100 years). A 100-year flood means a flood with a 1% annual probability of occurring.
Relocation Costs	Relocation costs are incurred when occupants must be relocated for construction of the mitigation project. In such cases, the relocation costs are an integral part of the mitigation project and must be counted in the total mitigation project costs.
Relocation (Mitigation Measure)	Relocation is a flood hazard mitigation alternative available in some situations. Relocation entails moving a structure out of the floodplain.
Rent, Total Monthly	Total monthly rent is the amount of rent paid by all tenants in the structure. For a public/nonprofit building, the rent value entered should be only the rent for that portion, if any, rented to private tenants.
Rental Income Losses	Rental income losses are lost payments normally paid by private tenants for all or a portion of the building. Inter- or intra-agency rents within the Federal Government are **not** counted because such payments are generally transfers and their loss does not represent a true economic loss.
Scenario Damages	Scenario damages are the damages per flood occurrence (i.e., event) of a given flood depth. In the program, scenario damages are expressed in 1-foot flood-depth increments from -2 to +8 feet or greater.
Scenario Damages After Mitigation	Scenario damages after mitigation are the estimated damages and losses from a single flood of a particular depth at the building after completion of the mitigation project. Scenario damages do **NOT** depend on the probability of floods at a location.
Scenario Damages Before Mitigation	Scenario damages are the damages and losses from a single flood of a particular depth at the building under evaluation before completion of the mitigation project. Scenario damages do **NOT** depend on the probability of floods at that location.
Scenario Run Identification	The scenario run identification is a number or name that will distinguish this particular analysis from others with different inputs or assumptions.
Stories Above Grade	Stories above grade are the number of stories above ground level in this building.
Total Building Replacement Value	The total building replacement value is the product of the building replacement value per square foot and the building size.

Total Floor Area

The Total Floor Area, in square feet (sf), is the size of the entire building. This is equal to the product of the building footprint and the number of stories above ground. The total floor area does not include basement or crawl space area.

Total Mitigation Project Costs

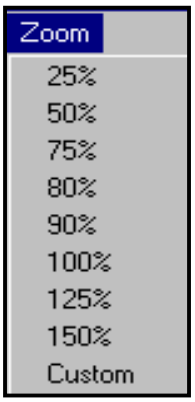
Total mitigation project costs are the sum of the project costs and relocation costs necessary for the project.

Unprotected Blocks

Blocks that are colored green, blue, and red are unprotected. Unprotected blocks can be changed by the user. See **Protected Blocks**.

Zoom List Box

The zoom list box is the rectangular box in the second row at the top of the Excel window, which may be adjusted for the size of an individual computer screen display.



APPENDIX 1
ECONOMIC ASSUMPTIONS AND EQUATIONS

Benefit-Cost (BC) Program

The benefits of a Riverine Flood hazard mitigation project are the **avoided** future damages and losses (i.e., the extent to which the mitigation project is effective in reducing expected future damages and losses). The net present value of benefits accounts for the time value of money.

Benefits are expected to accrue in the future: dollars received in the future have a present value which is less than dollars received immediately. The expected net present value of a flood hazard mitigation project is the sum of the present value of net benefits expected to accrue each year over the life of the project, minus the initial cost of the mitigation project.

The expected net present value, NPV, is defined as:

$$NPV = \frac{B_1}{1+i} + \frac{B_2}{(1+i)^2} + \ldots + \frac{B_t}{(1+i)^t} + \ldots + \frac{B_T}{(1+i)^T} - INV$$

where:

NPV is the expected Net Present Value of the hazard mitigation project;

B is the expected annual net Benefit of the hazard mitigation project for year t;

i is the annual discount rate;

T is the length of the planning horizon (useful life or Time of the hazard mitigation project); and

INV is the initial investment (the cost of the project).

Each year's expected net benefit is discounted to its present value, then all years' expected net benefits are summed together to yield the total expected net present value. The planning horizon, or useful lifetime, of the hazard mitigation project varies depending on the type of project, with 30 to 50 years being common for building projects. The discount rate corrects benefits expected to be received in the future to their net present value.

If expected net benefits are constant each year over the life of the project, the expected Net Present Value equation is simplified to the constant annual benefits and one discount term representing the present value for the entire planning horizon. With this simplification, the expected net present value equation is reduced to:

$$NPV = B_t \left[\frac{1-(1+i)^{-T}}{i} \right] - INV$$

The above is the underlying equation which is used for the benefit-cost program in this technical manual.

There are two other factors which could be included in the expected net present value calculation: the **Salvage Value** of the mitigation investment at the end of the planning horizon and the A**nnual Costs to maintain** the effectiveness of the mitigation project.

However, the present value of the salvage value of flood hazard mitigation projects is generally quite small, because of the long planning horizons appropriate for building projects. Thus, salvage value is not considered in the BC Program. The annual maintenance costs of typical Section 404 or 406 flood hazard mitigation projects are generally small, but may be significant, especially for levee projects. Therefore, for completeness, the annual maintenance costs are included in the BC program.

Economic Assumptions for Modeling Benefits

Underlying Assumptions

The benefits of a riverine flood hazard mitigation project are the reduction in damages that would otherwise be expected. Expected annual benefits are defined as the sum of expected avoided damages and losses. There are three different types of damages which are considered: scenario damages, expected annual damages, and expected annual avoided damages.

Scenario Damages are the expected damages per flood of a given flood depth at the building.

Expected Annual Damages are the product of scenario damages and the expected annual number of floods of a given flood depth at the building.

Expected Annual Avoided Damages are the product of expected annual damages and the effectiveness of the mitigation measure in reducing damages at the building.

An example illustrating the above referenced damage terms follows:

Table 1

Flood Depth (ft)	Scenario Damages	Expected Annual Number of Floods	Expected Annual Damages	Effectiveness of Mitigation Measure	Expected Annual Avoided Damages
-2	$20,000	.10	$2,000	100%	$2,000
-1	$25,000	.05	$1,250	80%	$1,000
0	$35,000	.02	$700	50%	$350
1	$50,000	.01	$500	25%	$125
2	$85,000	.005	$425.	15%	$64

In the above example, the scenario damages indicate the expected damages each time a flood of the given depth occurs at the building site. Scenario damages do **not** depend on how frequently such floods are expected to occur. The annual flood probabilities indicate the degree of flood-related risk at the specific site under consideration. The expected annual damages are the product of scenario damages and annual flood probability.

Expected annual damages are the best estimate of the **average** damages per year expected at this site; such estimates do not indicate that these damages will occur every year. Expected annual damages are those damages which are expected to occur **without** undertaking the mitigation measure. The effectiveness of the mitigation measure is an estimate of how much expected damages will be reduced by the mitigation measure under consideration.

Benefits are Avoided Damages

The expected annual avoided damages (i.e., the annual benefits) are the product of expected annual damages and the effectiveness of the mitigation measure. The expected annual **avoided** damages are thus the expected annual **benefits** of undertaking the mitigation measure.

Detailed Economic Assumptions and Equations

Scenario Damages

Scenario damages (**SCD**) are the total damages per flood event. Thus, scenario damages are the sum of building damages (**BD**), contents damages (**CD**), displacement costs (**DIS**), lost business income (**LBI**), rental income losses (**RENT**), and the value of lost public/nonprofit services (**VLS**) for floods of each depth per flood event (scenario). Scenario damages are calculated separately before and after the mitigation measure for each flood depth from -2 to 18 feet:

$$\mathbf{SCD = BD + CD + DIS + LBI + RENT + VLS}$$

where:

SCD	is the total scenario (per flood event) damages;
BD	is the total building damage per flood event;
CD	is the total contents damage per flood event;
DIS	is the total displacement costs per flood event;
LBI	is the total lost business income per flood event;
RENT	is the total rental income losses per flood event; and
VLS	is the total value of lost public/nonprofit services per flood event.

Building Damages

Building damages (**BD**) are estimated as the product of the modified depth damage function (**MDDF**), the floor area of the building (**FA**), and the replacement value of the building per square foot (**BRV**). Building damages are calculated separately before and after the mitigation measure for each flood depth from -2 to 8 feet:

$$\mathit{BD = (MDDF) + (FA) + (BRV)}$$

where:

BD	is the total amount of Building Damage per flood event;
MDDF	is the Modified Depth Damage Function (including the demolition threshold percentage), expressed as a percentage of building replacement value for each flood depth;
FA	is the Building Floor area in square feet; and
BRV	is the Building Replacement Value per square foot.

Contents Damages

Contents damages (**CD**) are estimated as the product of the contents depth-damage function (**CDDF**) and the total building contents replacement value (**CRV**) for each flood depth. Contents damages are calculated separately before and after the mitigation measure for each flood depth from -2 to 8 feet:

$$CD = (CDDF)\ (CRV)$$

where:

CD is the total Contents Damage per flood event;

CDDF is the Contents Depth Damage Function, expressed as a percentage of contents replacement value for each flood depth; and

CRV is the total building Contents Replacement Value.

Displacement Expenses

Displacement (**DIS**) expenses are the products of the necessary Displacement Days (**DD**), the total Displacement Costs **(DC)** per square foot per day, and the Total Area (**TA**) occupied by the owner agency or public or nonprofit agencies. Displacement costs are calculated separately before and after the mitigation measure for each flood depth from -2 to 8 feet:

$$DIS = (DD)\ (DC)\ (TA)$$

where:

DIS is the Displacement cost per flood event;

DD is the estimated number of Displacement Days expected for each flood depth;

DC is the Displacement Costs per square foot per day; and

TA is the Total Area occupied by the owner agency or public or nonprofit agencies.

Lost Business Income

Lost business income (**LBI**) is included if all or a portion of the building is rented to commercial businesses. **LBI** is the product of the Net Income of Commercial Businesses (**NICB**) per day and the number of Functional Downtime Days (**FDD**). LBI is calculated separately before and after the mitigation measure for each flood depth from -2 to 8 feet:

$$LBI = (NCIB)\ (FDD)$$

where:

LBI is the total Lost Business Income per flood event;

NICB is the Net Income of Commercial Businesses per day; and

FDD is the estimated number of Functional Downtime Days expected for each flood depth.

Rental Income Losses

Rental income losses (**RENT**) are included if all or a portion of the building is rented to private tenants. Inter- or intra-agency rents within the Federal, State, or local governments are **not** counted because such payments are generally transfers; loss of such payments does not represent a true economic loss. Other private sector economic losses (such as lost wages) are not considered because they are assumed to be generally negligible for public/nonprofit buildings.

Rental income losses (**RENT**) are the product of the expected Displacement Days (**DD**) and the Daily Rental Rate (**DRR**). Rental income losses are calculated separately before and after the mitigation measure for each flood depth from -2 to 8 feet:

$$RENT = (DD)\ (DRR)$$

where:

RENT is the total Rental income lost per flood event;

DD is the estimated number of expected Displacement Days for each flood depth; and

DRR is the Daily Rental Rate.

Public/Nonprofit Services Lost

For public/nonprofit sector buildings, the Value of Services Lost (**VLS**) when the building becomes unusable during a flood must be included. Public/nonprofit services are valued using the Quasi-Willingness to Pay (**QWTP**) model. **QWTP** is a simple methodology that assumes that public/nonprofit services are worth what we pay to provide the services.

VLS is the product of the total Value of Lost Services (**VOLS**) per day and the number of Functional Downtime Days (**FDD**). The period of lost services depends on the agency's ability to find alternative quarters and to establish normal functions. This period may vary depending on the structure, size, and function of the agency and the availability of suitable quarters after the flood. Note that the period of loss of agency function may be much shorter than the period of displacement necessary due to flood damage, because agencies will resume their functions in temporary quarters. The value of public/nonprofit services lost is calculated separately before and after the mitigation measure for each flood depth from -2 to 8 feet:

$$VLS = (VOLS)\ (FDD)$$

where:

VLS is the Value of agency Lost Services per flood event;

VOLS the total Value of Lost Services per day; and

FDD is the estimated number of Functional Downtime Days expected for each flood depth.

Expected Annual Damages

Expected Annual Damages (**EAD**) are the product of Scenario Damages (**SCD**) and the Expected Annual number of flood Events (**EAE**) of a given depth. Expected Annual Damages are calculated separately before and after the mitigation measure for each flood depth from -2 to 8 feet:

$$EAD = (SCD)\ (EAE)$$

where:

EAD is the Expected Annual Damages;

SCD is the total Scenario Damages (as defined previously); and

EAE is the Expected Annual number of flood Events of a given depth.

Expected Annual Benefits

Expected Annual Benefits (**EAB**) are the product of Expected Annual Damages **before** mitigation ($\mathbf{EAD^B}$) and the Effectiveness of the mitigation measure (**EFF**). Expected Annual Benefits are calculated separately before and after the mitigation measure for each flood depth from -2 to 8 feet:

$$EAB = (EAD^B)\ (EFF)$$

where:

EAB is the Expected Annual Benefits;

$\boldsymbol{EAD^B}$ is the Expected Annual Damages before mitigation; and

EFF is the Effectiveness of the mitigation measure in reducing expected damage from a flood of a given depth.

Equivalently, expected annual benefits (***EAB***) are the difference between Expected Annual Damages before mitigation ($\boldsymbol{EAD^B}$) and Expected Annual Damages after mitigation ($\boldsymbol{EAD^A}$). Expected Annual Benefits are calculated for each flood depth from -2 to 8 feet:

$$EAB = EAD^B - EAD^A$$

where:

EAB is the Expected Annual Benefits;

$\boldsymbol{EAD^B}$ is the Expected Annual Damages before mitigation; and

$\boldsymbol{EAD^A}$ is the Expected Annual Damages after mitigation.

Total Expected Annual Benefits

The total expected Annual Benefits (**AB**) of a flood hazard mitigation project are the Expected Annual Benefits (**EAB**) summed over the full range of damaging floods considered (i.e., -2 feet to 8 feet):

$$AB = \sum_{D=-2}^{18} EAB$$

where:

AB	is the total expected Annual Benefits of a flood hazard mitigation project;
D	is the range of flood Depths considered;
-2	is the minimum damaging flood depth considered in the BC Program, -2 feet;
8	is the maximum flood depth considered in the BC Program, 8 feet; and
EAB	is the Expected Annual Benefits from each flood depth being considered.

Benefits

The Benefits (**B**) of a flood hazard mitigation project are the net present value of the total expected Annual Benefits (**AB**) over the useful lifetime of the hazard mitigation project (***T***) at an annual discount rate (***i***):

$$B = AB\left[\frac{1-(1+i)^{-T}}{i}\right]$$

where:

B	is the Benefits of a flood hazard mitigation project;
AB	is the total expected Annual Benefits of the hazard mitigation project;
T	is the useful lifetime of the hazard mitigation project; and
i	is the annual discount rate.

Costs

The total mitigation project Costs (***C***) is the sum of the mitigation Project Costs (***PC***), the net Present Value of the Annual Maintenance Costs (***PVAMC***), and the Relocation Costs (***RC***) for the mitigation project:

$$C = PC + PVAMC + RC$$

where:

C	is the total mitigation project Costs;
PC	is the mitigation Project Costs including construction and other costs but excluding relocation costs;
PVAMC	is the net Present Value of the Annual Maintenance Costs of the mitigation project; and
RC	is the Relocation Costs necessary for construction of the mitigation project.

Present Value of Annual Maintenance Costs

The net Present Value of the Annual Maintenance Costs (***PVAMC***) is the product of the Annual Maintenance Costs (***AMC***) and the Present Value Coefficient (***PVCOEFF***):

$$PVAMC = (AMC)\ (PVCOEFF)$$

where:

PVAMC is the net Present Value of the Annual Maintenance Costs of the mitigation project; and

AMC is the Annual Maintenance Costs of the mitigation project; and

PVCOEFF is the Present Value Coefficient, which depends on the discount rate and project useful lifetime.

Relocation Costs

Relocation Costs (***RC***) are product of the Relocation Time (***RT***) in months times the sum of Rental Costs per month (***RCOST***) and Other relocation costs per month (***OCOST***):

$$RC = (RT)\ (RCOST + OCOST)$$

where:

RC is the Relocation Costs necessary for construction of the mitigation project;

RT is the occupant Relocation Time in months necessary for construction of the mitigation project;

RCOST is the Rental Costs per month for temporary space during construction of the mitigation project; and

OCOST is the Other relocation costs per month that may be incurred during the temporary relocation.

Benefit-Cost Ratio

The Benefit-Cost Ratio (***BCR***) is the Benefits (***B***) of the mitigation project divided by the Costs (***C***) of the mitigation project:

$$BCR = B \div C$$

where:

BCR is the Benefit-Cost Ratio of the hazard mitigation project;

B is the Benefits of the hazard mitigation project; and

C is the total mitigation project Costs.

Present Value Criterion

The Present Value Criterion (***PVC***) is the Benefits (***B***) of the mitigation project minus the Costs (***C***) of the mitigation project:

where:

PVC	is the Present Value Criterion of the hazard mitigation project;
B	is the Benefits of the hazard mitigation project; and
C	is the total mitigation project Costs.

Technical Economic Terms

Benefit-Cost Analysis (BCA)

Benefit-cost analysis (BCA) provides estimates of the "benefits" and "costs" of a proposed project. The term "BCA" is used to denote economic analyses that apply either the maximum present value criterion or the benefit-cost ratio (BCR) criterion to evaluate prospective actions. Both costs and benefits are discounted to their net present value. The maximum present value criterion subtracts costs from benefits to determine if benefits exceed costs. BCRs provide an alternative evaluation: prospective actions in which benefits exceed costs have BCRs above 1.0. The logic of BCA requires that BCRs, and/or the present value criterion, be compared across competing alternatives.

Cost-Benefit Analysis

Cost-benefit analysis has identical economic assumptions to BCAs and differs only in the nomenclature used to describe the analysis. Subtle differences in meaning between benefit-cost and cost-benefit analyses have been discussed (Hurter et al., 1982). These authors prefer the term benefit-cost for three reasons:

1. Determining benefits is often the most difficult aspect of the analysis; if costs are placed first, the emphasis is wrong;
2. When ratios are used to compare projects, the ratio used is benefit-cost, not cost-benefit; and
3. Placing the word "costs" first seems to suggest a negative attitude toward projects. It should be noted, however, that economic concepts, particularly as reflected in a BCA, are completely neutral with respect to the undertaking of projects.

Cost-Effectiveness Analysis

Cost-effectiveness analysis identifies the least-cost way to achieve a stated objective; it is strictly a comparison among means to a given end (Andrews, 1982). Thus, cost effectiveness is the ability to achieve a given benefit at a minimum cost. **In cost effectiveness analysis, the merits of the objective itself are not evaluated in economic terms.** This approach is typically used to select methods of achieving specific environmental standards.

	The Stafford Act uses cost-effectiveness when it means that benefits exceed costs in '404, Hazard Mitigation, and '406, Public Assistance.
Economic Efficiency	Economic efficiency is attained when the economy is functioning in a way that maximizes the value of society's consumption over time (Ward and Deren, 1991). Economic efficiency may also be viewed as the contribution to overall social welfare (Leman, 1989). It is generally accepted that a BCR above 1.0 indicates an improvement in economic efficiency. A BCA however does not indicate whether the project is the "most efficient" allocation of scarce resources for two reasons. First, a BCA is an average rather than a marginal concept. The ratio indicates the relationship between benefits and costs for a given project size. Economic efficiency, however, requires that a project be sized where marginal benefits equal marginal costs, which maximizes the total net benefits. Second, a typical project BCA does not survey the complete array of spending alternatives for all public projects/programs unrelated to the project under analysis. Economic efficiency under a budget constraint would require that the marginal benefits for **all** public spending alternatives be equal.
Economic Impact Assessment	Economic impact assessment is both simpler and broader than either a BCA or cost-effectiveness analysis in that it does not necessarily require aggregation or even categorization of effects as costs or benefits. It requires only the projection of economic effects of proposed actions and the listing of these for consideration. Impact assessment is broader than a BCA or a cost-effectiveness analysis because it includes identification of all economic impacts: the changes in total (direct, indirect, and induced) regional employment and income created by the proposed project. The inclusion of indirect and induced regional economic benefits and costs in a formal BCA are not generally accepted by the economics profession. Many economists maintain that such indirect and induced economic impacts represent a change in the distribution of economic activity and should not be confused with true gains in economic efficiency.
Informal BCA	Informal BCA embraces an indefinite range of procedures for the general identification and balancing of desirable and undesirable effects of proposed actions on society. Thus, an informal BCA simply approximates pure common sense, and it should not be compared with formal economic analyses of prospective projects.
Risk-Benefit Analysis	Risk-benefit analysis compares the economic benefits of a proposed project with the environmental and/or health-safety risks that are also created by the project. Ideally, the environmental and/or health-safety risks should be quantified in economic terms which in many cases is almost, if not impossible.

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